# PREDICTIONS OF ATOMIC ENERGY LEVELS BY EXTRAPOLATION ALONG ISOELECTRONIC SEQUENCES: HELIUM THROUGH SODIUM

by

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# THESIS

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ABSTRACT

Approximately 900 unknown atomic energy levels were predicted by extrapolation along the helium through sodium isoelectronic sequences. The extrapolations, based on well known regularities in atomic spectra, extend beyond the range of known values providing predictions in highly ionized atoms. The predicted energy levels are presented, along with the known values, in tabular form. In addition, as an aid to spectroscopists, 116 transitions are listed with known and predicted wavelengths. Since the majority of the energy level predictions are in highly ionized atoms, most of the predicted wavelengths fall in the vacuum ultraviolet region of the spectrum.

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## ACKNOWLEDGEMENTS

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# I. INTRODUCTION

Identified atomic energy levels provide an indispensable tool for scientists in many fields. Scientists in astrophysics, plasma physics, physical chemistry, atomic physics and nuclear physics as well as many related fields rely heavily on the proper identification of atomic energy levels and the corresponding transition values.

The first decisive step towards a systematic description of atomic spectra was taken by Rydberg, who published his findings in 1890. In the 80 years following, great progress has been made in the identification and classification of atomic energy levels. An excellent selection of papers of historical interest may be found in a recent book by Hindmarsh [1]. The first major attempt to compile the identified levels resulted in the 1932 publication of Bacher and Goudsmit [2]. Work continued in spectral analysis and soon the number of identified levels increased many fold. A more recent compilation of levels was completed by Moore [487] in 1958.[1]

Although tens of thousands of levels are now identified, great gaps exist in our knowledge. Some spectra are incompletely analyzed and others have no identified levels at all. A logical extension of our knowledge would be to fill these gaps in order to provide this information for all users.

The indispensable means of energy level identification is analysis of experimentally obtained atomic spectra. The experiments on highly ionized atoms present difficulties which, in some cases, are almost impossible to overcome. In any event, it is helpful to the spectroscopist to have an estimate of the transition wavelength to plan optimum use of

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[1] Use of a previously established reference system precludes numbering of references in order of occurrence.

the experimental equipment and to aid in line identification. This estimate or prediction may be obtained by two methods. One approach would be to calculate the energy levels using, for example, the Hartree-Fock method. A thorough treatment of this method is given by Slater [3]. The Hartree-Fock method is extremely complex for all but the most simple atoms and yields results of insufficient accuracy. If exact values could be obtained by this method, the complexity of calculations would not be a deterrent.

The second means of energy level prediction is that of extrapolation or interpolation among known values. The validity of this procedure is based on well known regularities in atomic spectra. Extrapolations are relatively easy to do in routine fashion but have the disadvantage that extensions can be made only along levels which have previously identified values. The remainder of this thesis is devoted to the details of this method and results obtained.

## II. THEORY

This section is not indended to be a comprehensive discussion of atomic physics. The purpose is to review those concepts which apply directly to the extrapolation procedures used. A more detailed discussion of atomic structure can be found in many texts, including Herzberg [4], Kuhn [5], White [6] and Edlén [7].

### A. ISOELECTRONIC SEQUENCES

The name isoelectronic sequence is used to describe a sequence of an atom and ions having the same number of electrons. The sequence may start at any atom in the periodic table; for example, lithium. The neutral lithium atom with three electrons is designated Li I and its spectrum is frequently called the arc spectrum. The next heavier atom in the periodic table is beryllium. Since beryllium has four electrons, the removal of

one electron will leave the same number as Li I. This beryllium ion is designated Be II and its spectrum is called the first spark spectrum. The next heavier atom is boron. To make boron isoelectronic with Li I and Be II two electrons must be removed. This is designated B III and its spectrum is called the second spark spectrum. The isoelectronic sequence continues in the same manner throughout the periodic table. Since the sequence started with the neutral lithium atom it is called the lithium isoelectronic sequence. The roman numeral following the element is called the spectrum number.

## B. SPECTRAL NOTATION

### 1. One-Electron Systems

Quantum theory provides a means for specifying the external state of the atom. The quantum numbers n (principal), $\ell$ (orbital angular momentum), s (spin) and j (total angular momentum) are used to specify the possible states. The quantity (2s + 1) is called the multiplicity and represents the number of values of j. It is common to use letters to specify the value of $\ell$. These letters correspond to the numerical values: s = 0, p = 1, d = 2, f = 3, g = 4 and down the alphabet skipping the letter j. The quantum numbers are not independent but are related as follows:

$$n = 1, 2, 3, \ldots.$$

$$\ell = 0, 1, 2, \ldots. (n - 1)$$

$$s = \tfrac{1}{2}$$

$$j = \ell \pm s = \ell \pm \tfrac{1}{2} \text{ but must be} > 0$$

A typical notation is:

$$3^2 P_{3/2}$$

which means that:

$$n = 3$$

multiplicity = 2

$\ell = 1$

$j = 3/2$

2. Multielectron Systems

In the multielectron system each electron is described by a set of quantum numbers as discussed above. It is necessary to combine or couple the angular momenta described by the quantum numbers to form a representation of the entire system. Different assumptions about the manner of coupling lead to several coupling schemes. Few atoms satisfy completely the conditions for any one coupling scheme, so the one chosen represents only an approximation of the true coupling. The coupling schemes are labeled in a way which denotes the least important interaction among the several angular momenta.

a. L - S Coupling

L - S (or Russell-Saunders) coupling is used almost exclusively in this paper and, therefore, will be stressed. In the vector model of the atom, L - S coupling describes the case where the individual spins couple strongly among themselves, as do the orbital angular momenta. The spin-orbit interaction of the resultants is much weaker. Such coupling arises from the predominance of electrostatic over magnetic interactions, which is the case in light atoms. For this situation, the same notation can be used as for one-electron systems except that the capital letters S, L, and J refer to the resultant of the individual components. The actual process of determining the values of S, L, and J for a given electron configuration is too lengthly to present here. When equivalent electrons are involved, the Pauli exclusion principle limits the number of possible states. Let it suffice to give a typical notation example:

$$1s^2 2s^2 2p^2 \quad {}^3P_0$$

This represents a system of six electrons with the configuration $1s^2 2s^2 2p^2$. The state of the atom is described by the term ${}^3P_0$ which means that:

$$2S + 1 = 3 \text{ or } S = 1$$

$$L = 1$$

$$J = 0$$

This is only one of five possible terms (${}^3P_0$, ${}^3P_1$, ${}^3P_2$, ${}^1D_2$, ${}^1S_0$) arising from this configuration.

b. Other Coupling

If the spin-orbit interactions are large compared with the electrostatic interactions, as in heavy atoms, j-j coupling becomes dominant. Numerous schemes fall in the region intermediate between L - S and j-j coupling. Among these are those labeled j - K and L - K, where K is the quantum number of the atom's angular momentum (exclusive of the spin of the outermost electron).

3. Parent Terms

In most configurations, it is impossible to describe the state of a multielectron system uniquely with a single term. In such cases it is necessary to designate the parent term. As an example, consider the nitrogen atom, with seven electrons. If an electron is removed to form the ion, the ground configuration of the ion is $1s^2 2s^2 2p^2$. If an electron is added now to the parent ion in this configuration, it might go into a configuration $1s^2 2s^2 2p^2 3p$. Since, however, the ion could have been in a state described by ${}^3P_0$, ${}^3P_1$, ${}^3P_2$, ${}^1S_0$, or ${}^1D_2$, the state of the atom will be different (the energy levels different) depending on the state of the parent ion. We describe the state of the atom by including the parent term, as $1s^2 2s^2 2p^2 ({}^3P_0) 3p \ {}^2P_{\frac{1}{2}}$ or $1s^2 2s^2 2p^2 ({}^1S_0) 3p \ {}^2P_{\frac{1}{2}}$.

4. Parity

If the wave function is reflected through the origin, the function is found to be either unchanged or changed in sign only. The function is accordingly called even or odd. This property, which is defined for every atomic state, is parity. The parity can be determined from the configuration. If the sum of all $\ell$'s is even or odd, the parity is correspondingly even or odd. Odd parity is designated by a superscript $^{o}$ on the term, for example $^{3}P_{1}^{o}$.

C. TERM RELATIONSHIPS

Since members of an isoelectronic sequence contain the same number of electrons, we expect the term systems to be identical except for the numerical values of the terms. Thus, it should be possible to predict values along a sequence from the known values if a suitable extrapolation formula can be found.

1. One-Electron Systems

One-electron systems are called hydrogenic since the electron configuration resembles that of hydrogen. The relativistic quantum treatment of the one-electron system leads to the following expression for the term energy T:

$$T_{n,\ell,j} = \frac{RchZ^2}{n^2} + \frac{Rch\alpha^2 Z^4}{n^3}\left(\frac{1}{\ell + \frac{1}{2}} - \frac{3}{4n}\right) - \frac{Rch\alpha^2 Z^4}{n^3}\left(\frac{j(j+1) - \ell(\ell+1) - s(s+1)}{\ell(2\ell+1)(\ell+1)}\right) \qquad (1)$$

where:

R = Rydberg constant

c = velocity of light

h = Planck's constant

$\alpha$ = fine structure constant

The first term in equation (1) is the Bohr expression for the term energy; the second term, the relativity correction; and the third term the spin-orbit interaction correction. For each term in the hydrogen isoelectronic sequence the only variable in equation (1) is Z. Quantum theory provides exactly the term energy values for the hydrogen isoelectronic sequence; therefore, the hydrogen sequence is of little interest for extrapolation, but equation (1) is quite important in the application to multielectron systems.

2. Multielectron Systems

In multielectron systems it is necessary to introduce the concept of effective nuclear charge, $Z - \sigma$, where $\sigma$ is the screening constant. The screening constant accounts for the fact that in multielectron systems the outer electrons are not subjected to full electrostatic attraction by the nucleus; part of the nuclear charge is screened by the inner core electrons. Substituting $Z - \sigma$ for Z in equation (1) gives a fourth degree polynomial in Z, assuming $\sigma$ is independent of Z. Actually, $\sigma$ is only approximately independent of Z but approaches true constancy for large Z.

3. Energy Level versus Term Value

The previous discussion applies to term value, which represents the energy of the system with respect to the ionization limit. The ionization energy is assigned a value of zero and the term value is measured down from the ionization limit. The energy level corresponding to the term value is customarily measured with respect to the ground state. The ground state is assigned a value of zero and the energy level is the value above the ground state. Thus the energy level is merely the ionization energy minus the term value. Since the ionization energy is expected to demonstrate a $Z^4$ dependence, it should be possible to express the energy level by a fourth degree polynomial in Z with appropriate changes in coefficients.

## D. RELATIVE TERM VALUES

Quantum mechanics provides formulae giving the relative positions of terms for a given configuration. This knowledge is very useful as a guide in empirical analysis. The following discussion applies only to L-S coupling.

### 1. Terms of Different L and S

A useful rule is that the lowest level of a given configuration of equivalent electrons (same n and l) is that with the largest value of S, and, if there are several of these, that with the largest value of L. This relationship, known as Hund's rule, is generally confirmed by observations on ground configurations, but many exceptions exist in excited configurations. The important fact to note is that regularities do exist which can be used as an aid in extrapolation. It is not necessary to rely solely on theory in extrapolation, however, as known values should provide the proper relationships.

### 2. Multiplet Structure

A multiplet is a set of levels characterized by the same values of L and S, but differing in values of J. The effect giving rise to multiplet structure is the spin-orbit term in equation (1). A doublet has two allowed J values, a triplet has three allowed J values, etc. If the energy of the levels increases with increasing J, the multiplet is described as normal. This is usually the case if the unfilled sub-shell is less than half filled. If the energy of the levels decreases with increasing J, the multiplet in inverted. This is usually the case if the sub-shell is more than half filled. For normal multiplets, the multiplet spacing tends to obey an interval rule which was first found empirically by Landé. It states that in a normal multiplet the differences between adjacent levels are in the ratio of their J values, where for each interval the higher of the two

J values is to be taken. Thus, the energy differences $^3P_2$ - $^3P_1$ and $^3P_1$ - $^3P_0$ are in the ratio 2:1. The Landé interval rule can be used to obtain the energy level of a multiplet member if the other members are known.

## E. PERTURBATIONS

The regular arrangement of term values is sometimes found to be disturbed. Deviations from the position expected by simple theory are called perturbations. One type of perturbation which is well defined is the so-called configuration interaction. Under certain conditions, terms belonging to different electron configurations will perturb each other. This occurs when both electron configurations are of the same parity and both terms have the same J value. In addition, in L-S coupling, observation shows that the greatest effect is to be expected when the two terms have the same L and S values.

## F. TRANSITIONS

The term value or energy level is not an experimentally measureable quantity. However, the energy difference between energy levels may be obtained experimentally by spectroscopic measurements. The change from one level to another is called a transition. Transitions cannot occur arbitrarily between levels but are restricted in dipole radiation. These restrictions or selection rules are as follows:

$$\Delta \ell = \pm 1 \text{ (Parity Change)}$$

$$\Delta J = 0, \pm 1 \text{ but } J = 0 \rightarrow J = 0 \text{ is forbidden}$$

$$\Delta L = 0, \pm 1$$

$$\Delta S = 0$$

The last two conditions are valid only to the extent that L-S coupling is a valid approximation. As we move further into intermediate coupling these rules are violated with greater frequency. A transition with $\Delta S \neq 0$ is

called an intercombination transition. These are quite weak in the spectra of light elements but become fairly strong in the heavy elements. The condition for $\Delta J$ holds in any coupling. The selection rules forbidding dipole transitions between terms of the same parity holds for all coupling schemes.

## III. EXTRAPOLATION PROCEDURES

### A. INPUT DATA

#### 1. Sources

Over the past several years Professor R. L. Kelly has conducted an extensive publications search collecting energy level data. The starting point was Moore [487] but hundreds of other references were used. This compilation continues today, as pertinent articles appear continuously in scientific journals. The data are stored in punch card format, with a card made for each energy level for which a value is known. Each card contains the following data:

Element

Spectrum Number

Atomic Number

Configuration and Term Description

Energy Level Value

Uncertainty Indicator

Reference Number

#### 2. Isoelectronic Sequence Term Listing

The initial step requires the organization of the energy level data in a manner which simplifies the selection of sequences to be investigated. A short program was written which lists the energy level cards for each term of the isoelectronic sequence. If the cards are input in ascending

order within the isoelectronic sequence, the listing by term is also in ascending order. This listing shows which terms have many identified levels and which terms have few.

## B. EXTENT OF INVESTIGATION

It was obvious at the outset that the time available would limit the isoelectronic sequences that could be examined. It was also necessary to limit the terms extrapolated within each isoelectronic sequence.

### 1. Isoelectronic Sequences

Because the hydrogen isoelectronic sequence is known completely, a logical starting point was the helium isoelectronic sequence. Investigation of ten isoelectronic sequences was selected as a reasonable goal. This encompassed all isoelectronic sequences from helium through sodium.

### 2. Terms

The isoelectronic sequence term listing was used to select terms to be extrapolated. (It should be noted here that some predictions are actually interpolations but the term extrapolation will be used in all cases.) Obviously, five known energy level values are required to obtain a unique fourth degree fit. In most cases, then, only those terms with five or more known energy levels were extrapolated. (In rare cases extrapolations were performed where three or four energy levels were known. In these cases only a second degree fit was used.) A further reduction was to consider only terms with configurations having all electrons with $n \leq 5$.

## C. EXTRAPOLATION PROGRAM

The program used to perform the extrapolations was a standard least-squares polynomial fit routine coupled with a plot routine. Input to the program consists of the atomic number and energy level value of the known

isoelectronic sequence members. The least-squares fit routine computes the polynomial coefficients and all energy level values up to $Z = 30$, the upper limit selected. The plot routine plots the known input points and superimposes over these the polynomial which gave the best fit. The program was restricted to the first through fourth degrees.

## D. EXTRAPOLATION DECISIONS

### 1. Degree Used

The first thing examined was the sign and magnitude of the coefficients. If the coefficient of $Z^4$ was negative, the fourth degree extrapolation was discarded, as theory does not support such a relationship. Next, the coefficient of $Z^2$ was examined. In rare cases this was also negative. In every case in which both second and fourth degree coefficients were negative, the polynomial plot indicated a possible first degree dependence. This is theoretically possible as the subtraction of the term value equation from the ionization energy equation could cause the higher order coefficients to vanish. In these cases the first degree fit was used for extrapolation. If the coefficient of $Z^4$ was negative, but the coefficient of $Z^2$ positive, the second degree fit was used. (Perturbations and/or incorrect input values were assumed to be responsible as the fourth degree fit is much more sensitive.) If the coefficient of $Z^4$ was positive it was checked for magnitude. In equation (1), the fourth degree terms contain $\alpha^2$, a very small number. Thus, the coefficient of $Z^4$ should be much smaller than the coefficient of $Z^2$. If this were not true, the second degree fit was used. Again, perturbations and/or incorrect input values could have caused the unduly large $Z^4$ coefficient.

### 2. Validity of Values

After selecting the degree the output was examined for curve fit. Naturally, the better the fit, the more confidence placed on the extrapolations.

Curve fits ranged from good to marginal. If the input values had eight significant figures, good curve fits agreed with input values to about six significant figures while marginal fits agreed to about four. The extrapolated values were only carried to a number of significant figures which agreed with the input values. Relationships other than extrapolations were used to verify values In multiplets, the Lande interval rule, when applicable, was used as a check. In singlets, comparison was made with other singlets or with the corresponding multiplet, if present, to insure continuation of relationships established in the input values. Violations were treated on an individual basis; in some cases the extrapolation was used for prediction, in others, the interval estimation was used.

3. <u>Extent of Extrapolation</u>

The number of values obtained from a given extrapolation was somewhat arbitrary, although the limit at Z = 30 was followed throughout. Presuming a constant percentage of correct input values, the greater the input the more valid the extrapolation. Thus, a general guide followed was to predict one value for every three input values. This guide was not followed when there were only a few known values or when the fit was exceptionally good.

# IV. RESULTS

The results are expressed in tables of two forms. Tables I, III, V, ..... XIX list the terms within each isoelectron sequence for which extrapolations were carried out. The columns present, from left to right: Element, spectrum number, atomic number, energy level value in reciprocal centimeters, and reference. Extrapolated values are enclosed in parentheses and can be further identified by the reference numbers 374 or 375. Those known values which have an uncertainty caused by doubtful identification or by lack of connection with the ground state are indicated by asterisks. In those cases where the extrapolated values differ significantly from the known values, and yet the extrapolation appears valid, the extrapolation value was listed along with the known value. Also, in cases where the multiplet could be resolved by the extrapolation, the extrapolated value was listed along with the unresolved value. All levels are designated by L-S notation. Since these tables are computer output, certain deviations from standard notation were necessary. Subscripts, superscripts and roman numerals were not used; therefore, all numbering falls on the line and arabic numbers are used throughout. Also fractions were not used, and fractional J values are represented by the next higher whole number. Finally, an asterisk is used to represent odd parity.

Tables II, IV, ..... XX list selected transitions within each isoelectronic sequence. The tables are presented as an aid to the spectroscopist who deals with transitions rather than energy levels. The transitions are listed down the left margin and the sequence members across the top. Those transitions involving at least one predicted level are indicated by parentheses. It is impractical to list all conceivable transitions so representative transitions which follow normal selection rules are listed.

# V. CONCLUSIONS

The test of the extrapolation procedures is the determination of how well the extrapolated levels compare with those deduced from observed transitions. Two recent papers list some energy levels or transitions involving energy levels which had been included in this project.

Tondello [776] observed transitions in the Si XI and Si XII spectrum using a laser produced plasma. To aid in line identification, he also used extrapolation techniques to predict transitions. Table XXI compares his work with predictions of this project. There is reasonably good agreement between the two sets of values, the wavelengths agreeing to within 0.1 Angstrom.

Gruzdev [GR69] calculated energy levels of the $2p^4$ and $2p^3 3s$ configurations in the spectra of the oxygen isoelectronic sequence from O I through Fe XIX, using the method of intermediate coupling in the single configuration approximation. Table XXII compares his work with extrapolations of this project. Within the $2p^4$ configuration the agreement is poor. The agreement within the $2p^3 3s$ configuration is much better, with less than one percent difference in all cases. Comparison by Gruzdev of his calculations against experimental values exhibited the same trend, that is, much better agreement in the $2p^3 3s$ configuration.

Of the 48 values compared against other sources 32 were within one percent difference. We conclude that it is possible, using extrapolation procedures, to predict energy levels with an accuracy that permits their use to first approximation. Certainly a first approximation is better than no approximation.

TABLE I HELIUM ISOELECTRONIC SEQUENCE

1S ( ) 2S 3S 1

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 159856.069 | 497 |
| LI | 2 | 3 | 476034.98 | 307 |
| BE | 3 | 4 | *956496.* | 487 |
| B | 4 | 5 | 1601505. | 487 |
| C | 5 | 6 | 2411266. | 487 |
| N | 6 | 7 | 3385850. | 072 |
| O | 7 | 8 | 4525340. | 487 |
| F | 8 | 9 | 5829920. | 487 |
| NE | 9 | 10 | *7295900.* | 373 |
| NA | 10 | 11 | (8931000.) | 374 |
| MG | 11 | 12 | (10729000.) | 374 |
| AL | 12 | 13 | (12692000.) | 374 |
| SI | 13 | 14 | (14819000.) | 374 |

1S ( ) 2S 1S 0

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 166277.546 | 497 |
| LI | 2 | 3 | 491374.6 | 775 |
| BE | 3 | 4 | (981100.) | 374 |
| B | 4 | 5 | (1635500.) | 374 |
| C | 5 | 6 | (2454500.) | 374 |
| N | 6 | 7 | (3438500.) | 374 |
| O | 7 | 8 | (4586500.) | 374 |
| F | 8 | 9 | 5899720. | 373 |
| NE | 9 | 10 | (7377500.) | 374 |

1S ( ) 2P 3P* 0

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 169087.9280 | 497 |
| LI | 2 | 3 | 494266.57 | 307 |
| BE | 3 | 4 | (983340.) | 375 |
| B | 4 | 5 | 1636898. | 487 |
| C | 5 | 6 | 2455165. | 487 |
| N | 6 | 7 | 3438270. | 487 |
| O | 7 | 8 | 4586330. | 202 |
| F | 8 | 9 | *5899150.* | 487 |
| NE | 9 | 10 | 7380600. | 559 |
| NA | 10 | 11 | 9025300. | 709 |
| MG | 11 | 12 | 10834200. | 709 |
| AL | 12 | 13 | (12810000.) | 374 |
| SI | 13 | 14 | (14950000.) | 374 |
| P | 14 | 15 | (17270000.) | 374 |
| S | 15 | 16 | (19760000.) | 374 |
| CL | 16 | 17 | (22420000.) | 374 |
| AR | 17 | 18 | 25233400. | 559 |
| K | 18 | 19 | 28250000. | 144 |
| CA | 19 | 20 | 31350000. | 144 |
| SC | 20 | 21 | 34720000. | 144 |
| TI | 21 | 22 | 38170000. | 144 |
| V | 22 | 23 | 41670000. | 144 |
| CR | 23 | 24 | 45660000. | 144 |
| MN | 24 | 25 | 49500000. | 144 |
| FE | 25 | 26 | 53760000. | 144 |
| CO | 26 | 27 | 58140000. | 144 |
| NI | 27 | 28 | 62500000. | 144 |
| CU | 28 | 29 | 67110000. | 144 |
| ZN | 29 | 30 | 71940000. | 144 |

TABLE I HELIUM ISOELECTRONIC SEQUENCE (cont.)

1S (      ) 2P   3P* 1

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 169086.9400 | 497 |
| LI | 2 | 3 | 494261.17 | 307 |
| BE | 3 | 4 | *983348.* | 487 |
| B | 4 | 5 | 1636882. | 487 |
| C | 5 | 6 | 2455152. | 487 |
| N | 6 | 7 | 3438280. | 487 |
| O | 7 | 8 | 4586390. | 202 |
| F | 8 | 9 | 5899310. | 487 |
| NE | 9 | 10 | 7380600. | 559 |
| NA | 10 | 11 | 9025300. | 709 |
| MG | 11 | 12 | 10834200. | 709 |
| AL | 12 | 13 | (12810000.) | 374 |
| SI | 13 | 14 | (14950000.) | 374 |
| P | 14 | 15 | (17270000.) | 374 |
| S | 15 | 16 | (19760000.) | 374 |
| CL | 16 | 17 | (22420000.) | 374 |
| AR | 17 | 18 | 25233400. | 559 |
| K | 18 | 19 | 28250000. | 144 |
| CA | 19 | 20 | 31350000. | 144 |
| SC | 20 | 21 | 34720000. | 144 |
| TI | 21 | 22 | 38170000. | 144 |
| V | 22 | 23 | 41670000. | 144 |
| CR | 23 | 24 | 45660000. | 144 |
| MN | 24 | 25 | 49500000. | 144 |
| FE | 25 | 26 | 53760000. | 144 |
| CO | 26 | 27 | 58140000. | 144 |
| NI | 27 | 28 | 62500000. | 144 |
| CU | 28 | 29 | 67110000. | 144 |
| ZN | 29 | 30 | 71940000. | 144 |

1S (      ) 2P   3P* 2

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 169086.8636 | 497 |
| LI | 2 | 3 | 494263.44 | 307 |
| BE | 3 | 4 | *983363.* | 487 |
| B | 4 | 5 | 1636934. | 487 |
| C | 5 | 6 | 2455288. | 487 |
| N | 6 | 7 | 3438570. | 487 |
| O | 7 | 8 | 4586940. | 202 |
| F | 8 | 9 | *5900260.* | 487 |
| NE | 9 | 10 | 7380600. | 559 |
| NA | 10 | 11 | 9025300. | 709 |
| MG | 11 | 12 | 10834200. | 709 |
| AL | 12 | 13 | (12810000.) | 374 |
| SI | 13 | 14 | (14950000.) | 374 |
| P | 14 | 15 | (17270000.) | 374 |
| S | 15 | 16 | (19760000.) | 374 |
| CL | 16 | 17 | (22420000.) | 374 |
| AR | 17 | 18 | 25233400. | 559 |
| K | 18 | 19 | 28250000. | 144 |
| CA | 19 | 20 | 31350000. | 144 |
| SC | 20 | 21 | 34720000. | 144 |
| TI | 21 | 22 | 38170000. | 144 |
| V | 22 | 23 | 41670000. | 144 |
| CR | 23 | 24 | 45660000. | 144 |
| MN | 24 | 25 | 49500000. | 144 |
| FE | 25 | 26 | 53760000. | 144 |
| CO | 26 | 27 | 58140000. | 144 |
| NI | 27 | 28 | 62500000. | 144 |
| CU | 28 | 29 | 67110000. | 144 |
| ZN | 29 | 30 | 71940000. | 144 |

TABLE I HELIUM ISOELECTRONIC SEQUENCE (cont.)

| | | | 1S ( ) 2P | 1P* 1 |
|---|---|---|---|---|
| HE | 1 | 2 | 171135.000 | 497 |
| LI | 2 | 3 | 501808.59 | 307 |
| BE | 3 | 4 | 997466. | 487 |
| B | 4 | 5 | 1658020. | 487 |
| C | 5 | 6 | 2483240. | 487 |
| N | 6 | 7 | 3473790. | 487 |
| O | 7 | 8 | 4629200. | 487 |
| F | 8 | 9 | 5949900. | 487 |
| NE | 9 | 10 | 7436600. | 559 |
| NA | 10 | 11 | 9090900. | 709 |
| MG | 11 | 12 | 10907300. | 487 |
| AL | 12 | 13 | 12891900. | 236 |
| SI | 13 | 14 | (15040000.) | 374 |
| P | 14 | 15 | (17350000.) | 374 |
| S | 15 | 16 | (19830000.) | 374 |
| CL | 16 | 17 | (22470000.) | 374 |
| AR | 17 | 18 | 25355000. | 559 |
| K | 18 | 19 | 28250000. | 144 |
| CA | 19 | 20 | 31350000. | 144 |
| SC | 20 | 21 | 34720000. | 144 |
| TI | 21 | 22 | 38170000. | 144 |
| V | 22 | 23 | 41670000. | 144 |
| CR | 23 | 24 | 45660000. | 144 |
| MN | 24 | 25 | 49500000. | 144 |
| FE | 25 | 26 | 53760000. | 144 |
| CO | 26 | 27 | 58140000. | 144 |
| NI | 27 | 28 | 62500000. | 144 |
| CU | 28 | 29 | 67110000. | 144 |
| ZN | 29 | 30 | 71940000. | 144 |

| | | | 1S ( ) 3S | 3S 1 |
|---|---|---|---|---|
| HE | 1 | 2 | 183236.892 | 497 |
| LI | 2 | 3 | 554754.45 | 307 |
| BE | 3 | 4 | (1121500.) | 374 |
| B | 4 | 5 | (1882500.) | 374 |
| C | 5 | 6 | (2839000.) | 374 |
| N | 6 | 7 | (3991000.) | 374 |
| O | 7 | 8 | 5337070. | 555 |
| F | 8 | 9 | (6878500.) | 374 |
| NE | 9 | 10 | (8615000.) | 374 |

TABLE I HELIUM ISOELECTRONIC SEQUENCE (cont.)

1S ( ) 3P 3P* 0

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 185564.9466 | 497 |
| LI | 2 | 3 | 559502.32 | 307 |
| BE | 3 | 4 | (1128000.) | 374 |
| B | 4 | 5 | (1892000.) | 374 |
| C | 5 | 6 | 2851370. | 262 |
| N | 6 | 7 | 4006120. | 262 |
| O | 7 | 8 | 5356380. | 487 |
| F | 8 | 9 | 6897570. | 373 |
| NE | 9 | 10 | *8640000.* | 262 |
| NA | 10 | 11 | (10580000.) | 374 |
| MG | 11 | 12 | (12710000.) | 374 |
| AL | 12 | 13 | (15060000.) | 374 |
| SI | 13 | 14 | (17600000.) | 374 |
| P | 14 | 15 | (20330000.) | 374 |
| S | 15 | 16 | (23240000.) | 374 |
| CL | 16 | 17 | (26340000.) | 374 |
| AR | 17 | 18 | 29670000. | 144 |
| K | 18 | 19 | 33110000. | 144 |
| CA | 19 | 20 | 36760000. | 144 |
| SC | 20 | 21 | 40650000. | 144 |
| TI | 21 | 22 | 44840000. | 144 |
| V | 22 | 23 | 49020000. | 144 |
| CR | 23 | 24 | 53480000. | 144 |
| MN | 24 | 25 | 58140000. | 144 |
| FE | 25 | 26 | 62890000. | 144 |
| CO | 26 | 27 | 68030000. | 144 |
| NI | 27 | 28 | 73530000. | 144 |
| CU | 28 | 29 | 78740000. | 144 |
| ZN | 29 | 30 | 84750000. | 144 |

1S ( ) 3P 3P* 1

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 185564.6760 | 497 |
| LI | 2 | 3 | 559500.35 | 307 |
| BE | 3 | 4 | (1128000.) | 374 |
| B | 4 | 5 | (1892000.) | 374 |
| C | 5 | 6 | 2851370. | 262 |
| N | 6 | 7 | 4006120. | 262 |
| O | 7 | 8 | 5356380. | 487 |
| F | 8 | 9 | 6897570. | 373 |
| NE | 9 | 10 | *8640000.* | 262 |
| NA | 10 | 11 | (10580000.) | 374 |
| MG | 11 | 12 | (12710000.) | 374 |
| AL | 12 | 13 | (15060000.) | 374 |
| SI | 13 | 14 | (17600000.) | 374 |
| P | 14 | 15 | (20330000.) | 374 |
| S | 15 | 16 | (23240000.) | 374 |
| CL | 16 | 17 | (26340000.) | 374 |
| AR | 17 | 18 | 29670000. | 144 |
| K | 18 | 19 | 33110000. | 144 |
| CA | 19 | 20 | 36760000. | 144 |
| SC | 20 | 21 | 40650000. | 144 |
| TI | 21 | 22 | 44840000. | 144 |
| V | 22 | 23 | 49020000. | 144 |
| CR | 23 | 24 | 53480000. | 144 |
| MN | 24 | 25 | 58140000. | 144 |
| FE | 25 | 26 | 62890000. | 144 |
| CO | 26 | 27 | 68030000. | 144 |
| NI | 27 | 28 | 73530000. | 144 |
| CU | 28 | 29 | 78740000. | 144 |
| ZN | 29 | 30 | 84750000. | 144 |

1S (        ) 3P   3P* 2

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 185564.6540 | 497 |
| LI | 2 | 3 | 559501.42 | 307 |
| BE | 3 | 4 | (1128000.) | 374 |
| B | 4 | 5 | (1892000.) | 374 |
| C | 5 | 6 | 2851370. | 262 |
| N | 6 | 7 | 4006120. | 262 |
| O | 7 | 8 | 5356380. | 487 |
| F | 8 | 9 | 6897570. | 373 |
| NE | 9 | 10 | *8640000.* | 262 |
| NA | 10 | 11 | (10580000.) | 374 |
| MG | 11 | 12 | (12710000.) | 374 |
| AL | 12 | 13 | (15060000.) | 374 |
| SI | 13 | 14 | (17600000.) | 374 |
| P | 14 | 15 | (20330000.) | 374 |
| S | 15 | 16 | (23240000.) | 374 |
| CL | 16 | 17 | (26340000.) | 374 |
| AR | 17 | 18 | 29670000. | 144 |
| K | 18 | 19 | 33110000. | 144 |
| CA | 19 | 20 | 36760000. | 144 |
| SC | 20 | 21 | 40650000. | 144 |
| TI | 21 | 22 | 44840000. | 144 |
| V | 22 | 23 | 49020000. | 144 |
| CR | 23 | 24 | 53480000. | 144 |
| MN | 24 | 25 | 58140000. | 144 |
| FE | 25 | 26 | 62890000. | 144 |
| CO | 26 | 27 | 68030000. | 144 |
| NI | 27 | 28 | 73530000. | 144 |
| CU | 28 | 29 | 78740000. | 144 |
| ZN | 29 | 30 | 84750000. | 144 |

1S (        ) 3P   1P* 1

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 186209.471 | 497 |
| LI | 2 | 3 | 561752.82 | 307 |
| BE | 3 | 4 | 1132323. | 487 |
| B | 4 | 5 | 1898180. | 487 |
| C | 5 | 6 | 2859350. | 487 |
| N | 6 | 7 | 4016390. | 487 |
| O | 7 | 8 | 5368550. | 487 |
| F | 8 | 9 | 6916590. | 487 |
| NE | 9 | 10 | 8662500. | 559 |
| NA | 10 | 11 | 10604000. | 709 |
| MG | 11 | 12 | 12738400. | 487 |
| AL | 12 | 13 | 15072700. | 236 |
| SI | 13 | 14 | (17620000.) | 374 |
| P | 14 | 15 | (20340000.) | 374 |
| S | 15 | 16 | (23250000.) | 374 |
| CL | 16 | 17 | (26350000.) | 374 |
| AR | 17 | 18 | 29744200. | 559 |
| K | 18 | 19 | 33110000. | 144 |
| CA | 19 | 20 | 36760000. | 144 |
| SC | 20 | 21 | 40650000. | 144 |
| TI | 21 | 22 | 44840000. | 144 |
| V | 22 | 23 | 49020000. | 144 |
| CR | 23 | 24 | 53480000. | 144 |
| MN | 24 | 25 | 58140000. | 144 |
| FE | 25 | 26 | 62890000. | 144 |
| CO | 26 | 27 | 68030000. | 144 |
| NI | 27 | 28 | 73530000. | 144 |
| CU | 28 | 29 | 78740000. | 144 |
| ZN | 29 | 30 | 84750000. | 144 |

TABLE I HELIUM ISOELECTRONIC SEQUENCE (cont.)

1S ( ) 3D 3D 1

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 186101.691 | 497 |
| LI | 2 | 3 | 561244.30 | 307 |
| BE | 3 | 4 | (1131500.) | 374 |
| B | 4 | 5 | (1897000.) | 374 |
| C | 5 | 6 | 2857308. | 487 |
| N | 6 | 7 | 4013550. | 262 |
| O | 7 | 8 | 5364990. | 487 |
| F | 8 | 9 | *6912360.* | 487 |
| NE | 9 | 10 | 8657700. | 559 |
| NA | 10 | 11 | (10600000.) | 374 |
| MG | 11 | 12 | (12740000.) | 374 |

1S ( ) 3D 3D 2

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 186101.646 | 497 |
| LI | 2 | 3 | 561243.15 | 307 |
| BE | 3 | 4 | (1131500.) | 374 |
| B | 4 | 5 | (1897000.) | 374 |
| C | 5 | 6 | 2857308. | 487 |
| N | 6 | 7 | 4013550. | 262 |
| O | 7 | 8 | 5364990. | 487 |
| F | 8 | 9 | 6912360. | 487 |
| NE | 9 | 10 | 8657700. | 559 |
| NA | 10 | 11 | (10600000.) | 374 |
| MG | 11 | 12 | (12740000.) | 374 |

1S ( ) 3D 3D 3

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 186101.643 | 497 |
| LI | 2 | 3 | 561243.77 | 307 |
| BE | 3 | 4 | (1131500.) | 374 |
| B | 4 | 5 | (1897000.) | 374 |
| C | 5 | 6 | 2857308. | 487 |
| N | 6 | 7 | 4013550. | 262 |
| O | 7 | 8 | 5364990. | 487 |
| F | 8 | 9 | *6912360.* | 487 |
| NE | 9 | 10 | 8657700. | 559 |
| NA | 10 | 11 | (10600000.) | 374 |
| MG | 11 | 12 | (12740000.) | 374 |

1S ( ) 3D 1D 2

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 186105.065 | 497 |
| LI | 2 | 3 | 561273.62 | 307 |
| BE | 3 | 4 | (1131500.) | 374 |
| B | 4 | 5 | (1897000.) | 374 |
| C | 5 | 6 | 2857410. | 262 |

TABLE I HELIUM ISOELECTRONIC SEQUENCE (cont.)

| | | | 1S ( ) 4P | 3P* 0 |
|---|---|---|---|---|
| HE | 1 | 2 | 191217.14 | 497 |
| LI | 2 | 3 | 581885.58 | 307 |
| BE | 3 | 4 | (1178000.) | 374 |
| B | 4 | 5 | (1980000.) | 374 |
| C | 5 | 6 | 2988400. | 262 |
| N | 6 | 7 | 4202580. | 262 |
| O | 7 | 8 | 5624000. | 555 |
| F | 8 | 9 | (7251000.) | 374 |
| NE | 9 | 10 | *9078400.* | 262 |
| NA | 10 | 11 | (11120000.) | 374 |

| | | | 1S ( ) 4P | 3P* 1 |
|---|---|---|---|---|
| HE | 1 | 2 | 191217.14 | 497 |
| LI | 2 | 3 | 581885.98 | 307 |
| BE | 3 | 4 | (1178000.) | 374 |
| B | 4 | 5 | (1980000.) | 374 |
| C | 5 | 6 | 2988400. | 262 |
| N | 6 | 7 | 4202580. | 262 |
| O | 7 | 8 | 5624000. | 555 |
| F | 8 | 9 | (7251000.) | 374 |
| NE | 9 | 10 | *9078400.* | 262 |
| NA | 10 | 11 | (11120000.) | 374 |

| | | | 1S ( ) 4P | 3P* 2 |
|---|---|---|---|---|
| HE | 1 | 2 | 191217.14 | 497 |
| LI | 2 | 3 | 581886.70 | 307 |
| BE | 3 | 4 | (1178000.) | 374 |
| B | 4 | 5 | (1980000.) | 374 |
| C | 5 | 6 | 2988400. | 262 |
| N | 6 | 7 | 4202580. | 262 |
| O | 7 | 8 | 5624000. | 555 |
| F | 8 | 9 | (7251000.) | 374 |
| NE | 9 | 10 | *9078400.* | 262 |
| NA | 10 | 11 | (11120000.) | 374 |

| | | | 1S ( ) 4P | 1P* 1 |
|---|---|---|---|---|
| HE | 1 | 2 | 191492.817 | 497 |
| LI | 2 | 3 | 582830.11 | 307 |
| BE | 3 | 4 | 1179830. | 487 |
| B | 4 | 5 | 1982750. | 487 |
| C | 5 | 6 | 2991680. | 487 |
| N | 6 | 7 | 4206810. | 487 |
| O | 7 | 8 | 5628100. | 487 |
| F | 8 | 9 | 7256680. | 487 |
| NE | 9 | 10 | 9090100. | 559 |
| NA | 10 | 11 | (11132000.) | 374 |
| MG | 11 | 12 | 13381100. | 487 |
| AL | 12 | 13 | 15838600. | 236 |
| SI | 13 | 14 | (18504000.) | 374 |
| P | 14 | 15 | (21380000.) | 374 |
| S | 15 | 16 | (24465000.) | 374 |
| CL | 16 | 17 | (27761000.) | 374 |
| AR | 17 | 18 | 31269500. | 559 |
| K | 18 | 19 | (34990000.) | 374 |
| CA | 19 | 20 | (38925000.) | 374 |

TABLE I HELIUM ISOELECTRONIC SEQUENCE (cont.)

1S ( ) 5P 3P* 0

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 193800.78 | 497 |
| LI | 2 | 3 | 592133.65 | 307 |
| BE | 3 | 4 | (1201000.) | 374 |
| B | 4 | 5 | (2020000.) | 374 |
| C | 5 | 6 | 3051350. | 262 |
| N | 6 | 7 | 4293040. | 262 |
| O | 7 | 8 | 5746490. | 555 |
| F | 8 | 9 | (7410000.) | 374 |
| NE | 9 | 10 | *9284000.* | 262 |
| NA | 10 | 11 | (11370000.) | 374 |

1S ( ) 5P 3P* 1

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 193800.78 | 497 |
| LI | 2 | 3 | 592134.03 | 307 |
| BE | 3 | 4 | (1201000.) | 374 |
| B | 4 | 5 | (2020000.) | 374 |
| C | 5 | 6 | 3051350. | 262 |
| N | 6 | 7 | 4293040. | 262 |
| O | 7 | 8 | 5746490. | 555 |
| F | 8 | 9 | (7410000.) | 374 |
| NE | 9 | 10 | *9284000.* | 262 |
| NA | 10 | 11 | (11370000.) | 374 |

1S ( ) 5P 3P* 2

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 193800.78 | 497 |
| LI | 2 | 3 | 592134.70 | 307 |
| BE | 3 | 4 | (1201000.) | 374 |
| B | 4 | 5 | (2020000.) | 374 |
| C | 5 | 6 | 3051350. | 262 |
| N | 6 | 7 | 4293040. | 262 |
| O | 7 | 8 | 5746490. | 555 |
| F | 8 | 9 | (7410000.) | 374 |
| NE | 9 | 10 | *9284000.* | 262 |
| NA | 10 | 11 | (11370000.) | 374 |

1S ( ) 5P 1P* 1

| | | | | |
|---|---|---|---|---|
| HE | 1 | 2 | 193942.57 | 497 |
| LI | 2 | 3 | 592634.91 | 307 |
| BE | 3 | 4 | 1201894. | 487 |
| B | 4 | 5 | 2022000. | 487 |
| C | 5 | 6 | 3053060. | 487 |
| N | 6 | 7 | (4294000.) | 374 |
| O | 7 | 8 | 5748450. | 487 |
| F | 8 | 9 | 7412900. | 709 |
| NE | 9 | 10 | 9289400. | 559 |
| NA | 10 | 11 | (11380000.) | 374 |
| MG | 11 | 12 | 13680600. | 487 |
| AL | 12 | 13 | (16190000.) | 374 |
| SI | 13 | 14 | (18910000.) | 374 |
| P | 14 | 15 | (21840000.) | 374 |
| S | 15 | 16 | (24980000.) | 374 |
| CL | 16 | 17 | (28325000.) | 374 |
| AR | 17 | 18 | 31877600. | 559 |
| K | 18 | 19 | (35650000.) | 374 |
| CA | 19 | 20 | (39635000.) | 374 |

TABLE II

TRANSITIONS - HELIUM ISOELECTRONIC SEQUENCE

| | | He I | Li II | Be III | B IV | C V | N VI | O VII | F VIII | Ne IX | Na X |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1s^2 - 2p$ | $^1S_0 - ^1P_1^o$ | 584.33 | 199.28 | 100.25 | 60.31 | 40.27 | 28.79 | 21.60 | 16.81 | 13.45 | 11.00 |
| $1s^2 - 3p$ | $^1S_0 - ^1P_1^o$ | 537.03 | 178.01 | 88.31 | 52.68 | 34.97 | 24.90 | 18.63 | 14.46 | 11.54 | 9.43 |
| $1s^2 - 4p$ | $^1S_0 - ^1P_1^o$ | 522.21 | 171.58 | 84.76 | 50.44 | 33.43 | 23.77 | 17.77 | 13.78 | 11.00 | (8.98) |
| $1s^2 - 5p$ | $^1S_0 - ^1P_1^o$ | 515.62 | 168.74 | 83.20 | 49.46 | 32.75 | 23.29 | 17.40 | 13.49 | 10.76 | (8.79) |
| $2s - 2p$ | $^3S_1 - ^3P_2^o$ | 10833.30 | 5485.93 | 3722.04 | 2822.55 | 2271.59 | 1896.81 | 1623.38 | 1421.67 | 1180.64 | (1060.45) |
| $2s - 3p$ | $^3S_1 - ^3P_2^o$ | 3889.75 | 1198.09 | (583.08) | (344.24) | (227.22) | 161.22 | 120.23 | 93.66 | 74.40 | (60.64) |
| | $^1S_0 - ^1P_1^o$ | 5017.08 | 1420.89 | (661.28) | (380.69) | (247.01) | (173.04) | (127.87) | 98.34 | (77.82) | |
| $2s - 4p$ | $^3S_1 - ^3P_2^o$ | 3188.67 | 944.72 | (451.46) | (264.20) | 173.27 | 122.44 | 91.02 | (70.37) | 56.10 | (45.68) |
| | $^1S_0 - ^1P_1^o$ | 3965.85 | 1093.43 | (503.20) | (287.98) | (186.16) | (130.15) | (96.01) | 73.69 | (58.39) | |
| $2s - 5p$ | $^3S_1 - ^3P_2^o$ | 2945.97 | 861.33 | (408.99) | (238.95) | 156.23 | 110.23 | 81.89 | (63.29) | 50.30 | (41.00) |
| | $^1S_0 - ^1P_1^o$ | 3614.67 | 987.55 | (452.91) | (258.73) | (167.07) | (116.89) | (86.06) | 66.09 | (52.30) | |
| $2p - 3d$ | $^3P_2^o - ^3D_3$ | 5877.24 | 1452.98 | (675.05) | (384.52) | 248.74 | 173.92 | 128.53 | 98.80 | 78.30 | (63.50) |
| | $^1P_1^o - ^1D_2$ | 6680.00 | 1681.66 | (746.08) | (418.45) | 267.26 | | | | | |
| $2p - 3s$ | $^3P_2^o - ^3S_1$ | 7067.12 | 1653.14 | (723.92) | (407.22) | (260.61) | (181.02) | 133.31 | (102.22) | (81.01) | |

Note: Transitiions in Angstroms

( ) indicates prediction.

# TABLE II

## TRANSITIONS - HELIUM ISOELECTRONIC SEQUENCE (continued)

| | | Mg XI | Al XII | Si XIII | P XIV | S XV | Cl XVI | Ar XVII | K XVIII | Ca XIX | Sc XX |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $1s^2 - 2p$ | $^1S_0 - {}^1P_1^o$ | 9.17 | 7.76 | (6.65) | (5.76) | (5.04) | (4.45) | 3.94 | 3.54 | 3.19 | 2.88 |
| $1s^2 - 3p$ | $^1S_0 - {}^1P_1^o$ | 7.85 | 6.63 | (5.68) | (4.92) | (4.30) | (3.79) | 3.36 | 3.02 | 2.72 | 2.46 |
| $1s^2 - 4p$ | $^1S_0 - {}^1P_1^o$ | 7.47 | 6.31 | (5.40) | (4.68) | (4.09) | (3.60) | 3.20 | (2.86) | (2.57) | |
| $1s^2 - 5p$ | $^1S_0 - {}^1P_1^o$ | 7.31 | (6.18) | (5.29) | (4.58) | (4.00) | (3.53) | 3.14 | (2.80) | (2.52) | |
| $2s - 2p$ | $^3S_1 - {}^3P_2^o$ | (950.57) | (847.46) | (763.36) | | | | | | | |
| $2s - 3p$ | $^3S_1 - {}^3P_2^o$ | (50.48) | (42.23) | (35.96) | | | | | | | |
| | $^1S_0 - {}^1P_1^o$ | | | | | | | | | | |
| $2s - 4p$ | $^3S_1 - {}^3P_2^o$ | | | | | | | | | | |
| | $^1S_0 - {}^1P_1^o$ | | | | | | | | | | |
| $2s - 5p$ | $^3S_1 - {}^3P_2^o$ | | | | | | | | | | |
| | $^1S_0 - {}^1P_1^o$ | | | | | | | | | | |
| $2p - 3d$ | $^3P_2^o - {}^3D_3$ | (52.47) | | | | | | | | | |
| | $^1P_1^o - {}^1D_2$ | | | | | | | | | | |
| $2p - 3s$ | $^3P_2^o - {}^3S_1$ | | | | | | | | | | |

TABLE III LITHIUM ISOELECTRONIC SEQUENCE

1S2 ( ) 3S 2S 1

| | | | | |
|---|---|---|---|---|
| LI | 1 | 3 | 27206.12 | 487 |
| BE | 2 | 4 | 88231.91 | 332 |
| B | 3 | 5 | 180201.8 | 487 |
| C | 4 | 6 | 302847.9 | 487 |
| N | 5 | 7 | 456129.7 | 313 |
| O | 6 | 8 | 640039.8 | 487 |
| F | 7 | 9 | 854625. | 487 |
| NE | 8 | 10 | 1100000. | 255 |
| NA | 9 | 11 | 1375944. | 487 |
| MG | 10 | 12 | 1682648. | 487 |
| AL | 11 | 13 | 2020460. | 487 |
| SI | 12 | 14 | 2390580. | 487 |
| P | 13 | 15 | 2794900. | 487 |
| S | 14 | 16 | (3223000.) | 374 |
| CL | 15 | 17 | (3685000.) | 374 |
| AR | 16 | 18 | (4178000.) | 374 |
| K | 17 | 19 | (4701000.) | 374 |
| CA | 18 | 20 | (5257000.) | 374 |

1S2 ( ) 3P 2P* 1

| | | | | |
|---|---|---|---|---|
| LI | 1 | 3 | 30925.38 | 487 |
| BE | 2 | 4 | 96495.36 | 332 |
| B | 3 | 5 | 192949.2 | 487 |
| C | 4 | 6 | 320048.5 | 487 |
| N | 5 | 7 | 477766.3 | 313 |
| O | 6 | 8 | 666113.2 | 487 |
| F | 7 | 9 | 885136. | 487 |
| NE | 8 | 10 | 1134900. | 255 |
| NA | 9 | 11 | 1415368. | 487 |
| MG | 10 | 12 | 1726519. | 487 |
| AL | 11 | 13 | 2068770. | 487 |
| SI | 12 | 14 | 2442000. | 774 |
| P | 13 | 15 | 2844390. | 487 |
| S | 14 | 16 | (3279000.) | 374 |
| CL | 15 | 17 | (3743000.) | 374 |
| AR | 16 | 18 | (4239000.) | 374 |
| K | 17 | 19 | (4765000.) | 374 |
| CA | 18 | 20 | (5322000.) | 374 |

1S2 ( ) 3P 2P* 2

| | | | | |
|---|---|---|---|---|
| LI | 1 | 3 | 30925.38 | 487 |
| BE | 2 | 4 | 96497.28 | 332 |
| B | 3 | 5 | 192959.4 | 487 |
| C | 4 | 6 | 320080.0 | 487 |
| N | 5 | 7 | 477843.2 | 313 |
| O | 6 | 8 | 666269.8 | 497 |
| F | 7 | 9 | 885418. | 487 |
| NE | 8 | 10 | 1134900. | 255 |
| NA | 9 | 11 | 1416130. | 487 |
| MG | 10 | 12 | 1727832. | 487 |
| AL | 11 | 13 | 2070520. | 487 |
| SI | 12 | 14 | 2444390. | 774 |
| P | 13 | 15 | 2850150. | 487 |
| S | 14 | 16 | (3284000.) | 374 |
| CL | 15 | 17 | (3750000.) | 374 |
| AR | 16 | 18 | (4247000.) | 374 |
| K | 17 | 19 | (4775000.) | 374 |
| CA | 18 | 20 | (5333000.) | 374 |

TABLE III LITHIUM ISOELECTRONIC SEQUENCE (cont.)

1S2 ( ) 3D 2D 2

| | | | | |
|---|---|---|---|---|
| LI | 1 | 3 | 31283.08 | 487 |
| BE | 2 | 4 | 98054.57 | 332 |
| B | 3 | 5 | 196068.1 | 168 |
| C | 4 | 6 | 324880.2 | 487 |
| N | 5 | 7 | 484404.0 | 313 |
| O | 6 | 8 | 674625.7 | 487 |
| F | 7 | 9 | 895632. | 487 |
| NE | 8 | 10 | 1147400. | 255 |
| NA | 9 | 11 | 1429980. | 487 |
| MG | 10 | 12 | 1743410. | 487 |
| AL | 11 | 13 | 2087980. | 487 |
| SI | 12 | 14 | 2463540. | 487 |
| P | 13 | 15 | 2870260. | 487 |
| S | 14 | 16 | (3308900.) | 375 |
| CL | 15 | 17 | (3777100.) | 375 |
| AR | 16 | 18 | (4280400.) | 374 |
| K | 17 | 19 | (4814500.) | 374 |
| CA | 18 | 20 | (5381000.) | 374 |

1S2 ( ) 3D 2D 3

| | | | | |
|---|---|---|---|---|
| LI | 1 | 3 | 31283.12 | 487 |
| BE | 2 | 4 | 98055.12 | 332 |
| B | 3 | 5 | 196071.2 | 487 |
| C | 4 | 6 | 324890.9 | 487 |
| N | 5 | 7 | 484426.5 | 313 |
| O | 6 | 8 | 674676.8 | 487 |
| F | 7 | 9 | 895722. | 487 |
| NE | 8 | 10 | 1147400. | 255 |
| NE | 8 | 10 | 1147600. | 374 |
| NA | 9 | 11 | 1430204. | 487 |
| MG | 10 | 12 | 1743880. | 487 |
| AL | 11 | 13 | 2088540. | 487 |
| SI | 12 | 14 | 2464530. | 487 |
| P | 13 | 15 | 2871620. | 487 |
| S | 14 | 16 | (3314000.) | 375 |
| CL | 15 | 17 | (3777700.) | 375 |
| AR | 16 | 18 | (4284000.) | 374 |
| K | 17 | 19 | (4819200.) | 374 |
| CA | 18 | 20 | (5387100.) | 374 |

1S2 ( ) 4S 2S 1

| | | | | |
|---|---|---|---|---|
| LI | 1 | 3 | 35012.06 | 487 |
| BE | 2 | 4 | 115464.40 | 332 |
| B | 3 | 5 | 237695.5 | 487 |
| C | 4 | 6 | 401346.7 | 487 |
| N | 5 | 7 | 606347.7 | 313 |
| O | 6 | 8 | 852696. | 487 |
| F | 7 | 9 | 1140416. | 487 |
| NE | 8 | 10 | 1469600. | 255 |
| NA | 9 | 11 | 1840336. | 487 |
| MG | 10 | 12 | (2253000.) | 374 |
| AL | 11 | 13 | (2707800.) | 374 |
| SI | 12 | 14 | (3205000.) | 374 |
| P | 13 | 15 | (3745300.) | 374 |
| S | 14 | 16 | (4329000.) | 374 |
| CL | 15 | 17 | (4956800.) | 374 |
| AR | 16 | 18 | (5629300.) | 374 |
| K | 17 | 19 | (6347300.) | 374 |
| CA | 18 | 20 | (7111500.) | 374 |

TABLE IV

TRANSITIONS - LITHIUM ISOELECTRONIC SEQUENCE

| | | Li I | Be II | B III | C IV | N V | O VI | F VII | Ne VIII | Na IX |
|---|---|---|---|---|---|---|---|---|---|---|
| 2s - 3p | ${}^2S_{1/2} - {}^2P^o_{1/2}$ | 3233.59 | 1036.32 | 518.27 | 312.45 | 209.31 | 150.12 | 112.98 | 88.11 | 70.65 |
| | ${}^2S_{1/2} - {}^2P^o_{3/2}$ | 3233.59 | 1036.29 | 518.24 | 312.42 | 209.27 | 150.09 | 112.94 | 88.11 | 70.62 |
| 2p - 3s | ${}^2P^o_{1/2} - {}^2S_{1/2}$ | 8128.46 | 1776.10 | 758.48 | 419.53 | 266.19 | 183.94 | 134.70 | 102.90 | 81.18 |
| | ${}^2P^o_{3/2} - {}^2S_{1/2}$ | 8128.68 | 1776.31 | 758.67 | 419.72 | 266.38 | 184.12 | 134.88 | 103.07 | 81.35 |
| 2p - 4s | ${}^2P^o_{1/2} - {}^2S_{1/2}$ | 4973.05 | 1197.09 | 528.16 | 296.86 | 190.15 | 132.22 | 97.26 | 74.55 | 58.95 |
| | ${}^2P^o_{3/2} - {}^2S_{1/2}$ | 4973.13 | 1197.19 | 528.26 | 296.95 | 190.25 | 132.31 | 97.35 | 74.64 | 59.04 |
| 2p - 3d | ${}^2P^o_{1/2} - {}^2D_{3/2}$ | 6105.22 | 1512.26 | 677.00 | 384.03 | 247.56 | 172.94 | 127.65 | 98.11 | 77.76 |
| | ${}^2P^o_{3/2} - {}^2D_{5/2}$ | 6105.33 | 1512.41 | 677.15 | 384.17 | 247.71 | 173.08 | 127.80 | (98.25) | 77.91 |

| | | Mg X | Al XI | Si XII | P XIII | S XIV | Cl XV | Ar XVI | K XVII | Ca XVIII |
|---|---|---|---|---|---|---|---|---|---|---|
| 2s - 3p | ${}^2S_{1/2} - {}^2P^o_{1/2}$ | 57.92 | 48.34 | 40.95 | 35.16 | (30.50) | (26.72) | (23.59) | (20.99) | (18.79) |
| | ${}^2S_{1/2} - {}^2P^o_{3/2}$ | 57.88 | 48.30 | 40.91 | 35.09 | (30.45) | (26.67) | (23.55) | (20.94) | (18.75) |
| 2p - 3s | ${}^2P^o_{1/2} - {}^2S_{1/2}$ | 65.67 | 54.21 | 45.48 | 38.65 | (33.35) | (29.04) | (25.51) | (22.59) | (20.14) |
| | ${}^2P^o_{3/2} - {}^2S_{1/2}$ | 65.84 | 54.39 | 45.66 | 38.83 | (33.52) | (29.21) | (25.68) | (22.77) | (20.32) |
| 2p - 4s | ${}^2P^o_{1/2} - {}^2S_{1/2}$ | (47.78) | (39.50) | (33.19) | (28.27) | (24.36) | (21.21) | (18.62) | (16.47) | (14.67) |
| | ${}^2P^o_{3/2} - {}^2S_{1/2}$ | (47.87) | (39.59) | (33.28) | (28.36) | (24.46) | (21.30) | (18.71) | (16.56) | (14.76) |
| 2p - 3d | ${}^2P^o_{1/2} - {}^2D_{3/2}$ | 63.15 | 52.30 | 44.02 | 37.56 | (32.42) | (28.28) | (24.86) | (22.03) | (19.65) |
| | ${}^2P^o_{3/2} - {}^2D_{5/2}$ | 63.30 | 52.45 | 44.16 | 37.70 | (32.53) | (28.43) | (25.00) | (22.17) | (19.79) |

Note: Transitions in Angstroms. ( ) indicates prediction.

TABLE V BERYLLIUM ISOELECTRONIC SEQUENCE

1S2 2S ( ) 2P 3P* 0

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 21978.28 | 333 |
| B | 2 | 5 | *37333.6* | 487 |
| C | 3 | 6 | 52367.06 | 034 |
| N | 4 | 7 | 67209.2 | 824 |
| O | 5 | 8 | 81939.2 | 083 |
| F | 6 | 9 | 96601. | 487 |
| NE | 7 | 10 | *111251.* | 071 |
| NA | 8 | 11 | *125913.* | 487 |
| MG | 9 | 12 | *140528.* | 487 |
| AL | 10 | 13 | *154850.* | 487 |
| SI | 11 | 14 | *169140.* | 487 |
| P | 12 | 15 | *183190.* | 487 |
| S | 13 | 16 | (198000.) | 374 |
| CL | 14 | 17 | (212000.) | 374 |
| AR | 15 | 18 | (226000.) | 374 |

1S2 2S ( ) 2P 3P* 1

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 21978.92 | 333 |
| B | 2 | 5 | *37340.* | 487 |
| C | 3 | 6 | 52390.75 | 034 |
| N | 4 | 7 | 67272.3 | 824 |
| O | 5 | 8 | 82075.3 | 083 |
| F | 6 | 9 | 96867. | 209 |
| NE | 7 | 10 | *111706.* | 071 |
| NA | 8 | 11 | *126643.* | 487 |
| MG | 9 | 12 | *141690.* | 209 |
| AL | 10 | 13 | *156540.* | 487 |
| SI | 11 | 14 | *171560.* | 487 |
| P | 12 | 15 | *186390.* | 487 |
| S | 13 | 16 | (202000.) | 374 |
| CL | 14 | 17 | (217000.) | 374 |
| CL | 14 | 17 | 250000. | 269 |
| AR | 15 | 18 | (232000.) | 374 |

1S2 2S ( ) 2P 3P* 2

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 21981.27 | 333 |
| B | 2 | 5 | *37356.4* | 487 |
| C | 3 | 6 | 52447.11 | 034 |
| N | 4 | 7 | 67416.3 | 824 |
| O | 5 | 8 | 82382.0 | 083 |
| F | 6 | 9 | 97437. | 487 |
| NE | 7 | 10 | *112700.* | 071 |
| NA | 8 | 11 | *128247.* | 487 |
| MG | 9 | 12 | *144162.* | 487 |
| AL | 10 | 13 | *160200.* | 487 |
| SI | 11 | 14 | *176810.* | 487 |
| P | 12 | 15 | *192990.* | 487 |
| S | 13 | 16 | (210000.) | 374 |
| CL | 14 | 17 | (227000.) | 374 |
| CL | 14 | 17 | 250000. | 269 |
| AR | 15 | 18 | (244000.) | 374 |

TABLE V   BERYLLIUM ISOELECTRONIC SEQUENCE (cont.)

1S2   2S (   ) 2P   1P* 1

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 42565.35 | 333 |
| B | 2 | 5 | 73396.7 | 487 |
| C | 3 | 6 | 102352.04 | 034 |
| N | 4 | 7 | 130693.9 | 824 |
| O | 5 | 8 | 158797.7 | 083 |
| F | 6 | 9 | 186841. | 487 |
| NE | 7 | 10 | 214952. | 071 |
| NA | 8 | 11 | 243223. | 487 |
| MG | 9 | 12 | 271687. | 487 |
| AL | 10 | 13 | 300400. | 487 |
| SI | 11 | 14 | 329700. | 827 |
| P | 12 | 15 | 358840. | 487 |
| S | 13 | 16 | (387000.) | 374 |
| CL | 14 | 17 | (415000.) | 374 |
| CL | 14 | 17 | *400000.* | 269 |
| AR | 15 | 18 | (444000.) | 374 |

1S2   2S (   ) 3S   3S 1

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 52080.94 | 333 |
| B | 2 | 5 | *129772.9* | 487 |
| C | 3 | 6 | 238213.00 | 034 |
| N | 4 | 7 | 377284.8 | 824 |
| O | 5 | 8 | 546969.4 | 083 |
| F | 6 | 9 | 747298. | 487 |
| NE | 7 | 10 | *978300.0* | 071 |
| NA | 8 | 11 | *1240115.* | 487 |
| MG | 9 | 12 | *1532491.* | 487 |
| AL | 10 | 13 | *1855510.* | 487 |
| SI | 11 | 14 | (2209000.) | 374 |
| P | 12 | 15 | *2594640.* | 487 |
| S | 13 | 16 | (3008000.) | 374 |
| CL | 14 | 17 | (3453000.) | 374 |
| AR | 15 | 18 | (3929000.) | 374 |

1S2   2S (   ) 3S   1S 0

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 54677.26 | 333 |
| B | 2 | 5 | 135946. | 487 |
| C | 3 | 6 | 247170.26 | 034 |
| N | 4 | 7 | 388854.6 | 824 |
| O | 5 | 8 | 561276.4 | 083 |
| F | 6 | 9 | 764392. | 487 |
| NE | 7 | 10 | 998400. | 255 |
| NA | 8 | 11 | 1262799. | 487 |
| MG | 9 | 12 | 1558076. | 487 |
| AL | 10 | 13 | 1884330. | 487 |
| SI | 11 | 14 | 2241480. | 487 |
| P | 12 | 15 | 2629250. | 487 |
| S | 13 | 16 | (3047000.) | 374 |
| CL | 14 | 17 | (3495000.) | 374 |
| AR | 15 | 18 | (3975000.) | 374 |

TABLE V BERYLLIUM ISOELECTRONIC SEQUENCE (cont.)

1S2 2S ( ) 3P 3P* 0

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 58907.47 | 333 |
| B | 2 | 5 | *143989.7* | 487 |
| C | 3 | 6 | 259705.55 | 034 |
| N | 4 | 7 | 405971.6 | 824 |
| O | 5 | 8 | 582803.1 | 083 |
| F | 6 | 9 | 790253. | KA60 |
| NE | 7 | 10 | *1028366.5* | 071 |
| NA | 8 | 11 | (1297400.) | 374 |
| MG | 9 | 12 | (1597400.) | 374 |
| AL | 10 | 13 | (1928600.) | 374 |

1S2 2S ( ) 3P 3P* 1

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 58907.47 | 333 |
| B | 2 | 5 | *143989.7* | 487 |
| C | 3 | 6 | 259711.22 | 034 |
| N | 4 | 7 | 405987.5 | 824 |
| O | 5 | 8 | 582839.8 | 083 |
| F | 6 | 9 | 790326. | 487 |
| NE | 7 | 10 | *1028499.3* | 071 |
| NA | 8 | 11 | (1297600.) | 374 |
| MG | 9 | 12 | (1597700.) | 374 |
| AL | 10 | 13 | (1929000.) | 374 |

1S2 2S ( ) 3P 3P* 2

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 58907.84 | 333 |
| B | 2 | 5 | *143993.4* | 487 |
| C | 3 | 6 | 259724.30 | 034 |
| N | 4 | 7 | 406022.8 | 824 |
| O | 5 | 8 | 582917.0 | 083 |
| F | 6 | 9 | 790474. | 487 |
| NE | 7 | 10 | *1028754.7* | 071 |
| NA | 8 | 11 | (1298000.) | 374 |
| MG | 9 | 12 | (1598400.) | 374 |
| AL | 10 | 13 | (1930000.) | 374 |

1S2 2S ( ) 3P 1P* 1

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 60187.36 | 333 |
| B | 2 | 5 | 144102.0 | 487 |
| C | 3 | 6 | 258931.29 | 034 |
| N | 4 | 7 | 404522.4 | 824 |
| O | 5 | 8 | 580824.9 | 083 |
| F | 6 | 9 | 787833. | 487 |
| NE | 7 | 10 | 1025200. | 255 |
| NA | 8 | 11 | 1294214. | 487 |
| MG | 9 | 12 | 1593600. | 487 |
| AL | 10 | 13 | 1923850. | 487 |
| SI | 11 | 14 | 2285040. | 487 |
| P | 12 | 15 | 2677740. | 487 |
| S | 13 | 16 | (3101500.) | 374 |
| CL | 14 | 17 | (3556700.) | 374 |
| AR | 15 | 18 | (4043600.) | 374 |
| K | 16 | 19 | (4562300.) | 374 |

TABLE V BERYLLIUM ISOELECTRONIC SEQUENCE (cont.)

1S2 2S ( ) 3D 3D 1

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 62053.72 | 333 |
| B | 2 | 5 | *150649.0* | 487 |
| C | 3 | 6 | 270010.83 | 034 |
| N | 4 | 7 | 420045.8 | 824 |
| O | 5 | 8 | 600745.6 | 083 |
| F | 6 | 9 | 812169. | 487 |
| NE | 7 | 10 | (1054370.) | 375 |
| NA | 8 | 11 | *1327259.* | 487 |
| MG | 9 | 12 | *1631063.* | 487 |
| AL | 10 | 13 | *1965560.* | 487 |
| SI | 11 | 14 | *2330650.* | 487 |
| P | 12 | 15 | *2726690.* | 487 |
| S | 13 | 16 | (3150500.) | 374 |
| CL | 14 | 17 | (3608000.) | 374 |
| AR | 15 | 18 | (4096000.) | 374 |

1S2 2S ( ) 3D 3D 2

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 62053.72 | 333 |
| B | 2 | 5 | *150649.0* | 487 |
| C | 3 | 6 | 270011.93 | 034 |
| N | 4 | 7 | 420049.6 | 824 |
| O | 5 | 8 | 600755.6 | 083 |
| F | 6 | 9 | 812169. | 487 |
| NE | 7 | 10 | 1054410. | 255 |
| NA | 8 | 11 | *1327296.* | 487 |
| MG | 9 | 12 | *1631226.* | 487 |
| AL | 10 | 13 | *1965770.* | 487 |
| SI | 11 | 14 | *2331160.* | 487 |
| P | 12 | 15 | *2727190.* | 487 |
| S | 13 | 16 | *3152500.* | 269 |
| CL | 14 | 17 | (3609000.) | 374 |
| CL | 14 | 17 | *3645600.* | 269 |
| AR | 15 | 18 | (4097000.) | 374 |

1S2 2S ( ) 3D 3D 3

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 62053.72 | 333 |
| B | 2 | 5 | *150649.0* | 487 |
| C | 3 | 6 | 271014.74 | 034 |
| N | 4 | 7 | 420058.0 | 824 |
| O | 5 | 8 | 600775.9 | 083 |
| F | 6 | 9 | 812208. | 487 |
| NE | 7 | 10 | 1054480. | 255 |
| NA | 8 | 11 | *1327417.* | 487 |
| MG | 9 | 12 | *1631394.* | 487 |
| AL | 10 | 13 | *1966050.* | 487 |
| SI | 11 | 14 | *2331940.* | 487 |
| P | 12 | 15 | *2727840.* | 487 |
| S | 13 | 16 | *3152500.* | 269 |
| CL | 14 | 17 | (3606000.) | 374 |
| CL | 14 | 17 | *3638700.* | 269 |
| AR | 15 | 18 | (4093000.) | 374 |

1S2 2S ( ) 3D 1D 2

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 64428.31 | 333 |
| B | 2 | 5 | 154686.9 | 487 |
| C | 3 | 6 | 276482.86 | 034 |
| N | 4 | 7 | 429159.6 | 824 |
| O | 5 | 8 | 612615.6 | 083 |
| F | 6 | 9 | 826853. | 487 |
| NE | 7 | 10 | 1072200. | 255 |
| NA | 8 | 11 | 1347756. | 487 |
| MG | 9 | 12 | 1654583. | 487 |
| AL | 10 | 13 | 1992250. | 487 |
| SI | 11 | 14 | 2361310. | 827 |
| P | 12 | 15 | 2760490. | 487 |
| S | 13 | 16 | (3191000.) | 374 |
| CL | 14 | 17 | *3634200.* | 269 |
| CL | 14 | 17 | (3653000.) | 374 |
| AR | 15 | 18 | (4146000.) | 374 |

1S2 2S ( ) 4S 3S 1

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 64506.43 | 333 |
| B | 2 | 5 | *166344.4* | 487 |
| C | 3 | 6 | 309457.17 | 034 |
| N | 4 | 7 | 498045.5 | 824 |
| O | 5 | 8 | 722476.7 | 083 |
| F | 6 | 9 | 989928. | 487 |
| NE | 7 | 10 | 1298400. | 255 |
| NA | 8 | 11 | *1649542.* | 487 |
| MG | 9 | 12 | (2040000.) | 374 |
| AL | 10 | 13 | (2473000.) | 374 |

1S2 2S ( ) 4S 1S 0

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 65245.34 | 333 |
| B | 2 | 5 | 167934.2 | 487 |
| C | 3 | 6 | 311721.51 | 034 |
| N | 4 | 7 | (501800.) | 374 |
| O | 5 | 8 | 731670.5 | 083 |
| F | 6 | 9 | 997693. | 487 |
| NE | 7 | 10 | (1306500.) | 374 |
| NA | 8 | 11 | 1656830. | 487 |
| MG | 9 | 12 | (2052500.) | 374 |
| AL | 10 | 13 | (2498600.) | 374 |

1S2 2S ( ) 4P 1P* 1

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 67034.70 | 333 |
| B | 2 | 5 | (174800.) | 374 |
| C | 3 | 6 | 322404.20 | 034 |
| N | 4 | 7 | 507027.9 | 824 |
| O | 5 | 8 | 737880.8 | 083 |
| F | 6 | 9 | 1007852. | 487 |
| NE | 7 | 10 | 1319600. | 255 |
| NA | 8 | 11 | 1673388. | 487 |
| MG | 9 | 12 | 2068680. | 487 |
| AL | 10 | 13 | (2504000.) | 374 |
| SI | 11 | 14 | 2982000. | 776 |

TABLE V BERYLLIUM ISOELECTRONIC SEQUENCE (cont.)

1S2 2S ( ) 5P 1P* 1

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 70120.49 | 333 |
| B | 2 | 5 | (182100.) | 374 |
| C | 3 | 6 | 343258.03 | 034 |
| N | 4 | 7 | 550232.6 | 824 |
| O | 5 | 8 | 802466. | 083 |
| F | 6 | 9 | 1099409. | 487 |
| NE | 7 | 10 | (1443800.) | 374 |
| NA | 8 | 11 | 1838911. | 487 |
| MG | 9 | 12 | (2290200.) | 374 |
| AL | 10 | 13 | (2804700.) | 374 |

1S2 2P ( 2P* ) 3S 3P* 0

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 85553.8 | 333 |
| B | 2 | 5 | *181645.2 * | 487 |
| C | 3 | 6 | 308216.58 | 034 |
| N | 4 | 7 | 465291.8 | 824 |
| O | 5 | 8 | 652914.7 | 083 |
| F | 6 | 9 | 871160. | 487 |
| NE | 7 | 10 | (1120100.) | 374 |
| NA | 8 | 11 | *1399718.* | 487 |
| MG | 9 | 12 | *1710220.* | 487 |
| AL | 10 | 13 | (2052000.) | 374 |

1S2 2P ( 2P* ) 3S 3P* 1

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 85556.11 | 333 |
| B | 2 | 5 | *181655.0* | 487 |
| C | 3 | 6 | 308248.91 | 034 |
| N | 4 | 7 | 465371.0 | 824 |
| O | 5 | 8 | 653076.8 | 083 |
| F | 6 | 9 | 871441. | 487 |
| NE | 7 | 10 | (1120500.) | 374 |
| NA | 8 | 11 | *1400523.* | 487 |
| MG | 9 | 12 | *1711314.* | 487 |
| AL | 10 | 13 | (2055000.) | 374 |

1S2 2P ( 2P* ) 3S 3P* 2

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 85560.11 | 333 |
| B | 2 | 5 | *181675.9* | 487 |
| C | 3 | 6 | 308317.29 | 034 |
| N | 4 | 7 | 465536.6 | 824 |
| O | 5 | 8 | 653420.0 | 083 |
| F | 6 | 9 | 872078. | 487 |
| NE | 7 | 10 | 1121800. | 255 |
| NA | 8 | 11 | *1402237.* | 487 |
| MG | 9 | 12 | *1713847.* | 487 |
| AL | 10 | 13 | *2056910.* | 487 |

1S2 2P ( 2P* ) 3S 1P* 1

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | (82000.) | 374 |
| B | 2 | 5 | (181000.) | 374 |
| C | 3 | 6 | 310006.32 | 034 |
| N | 4 | 7 | 473029.3 | 824 |
| O | 5 | 8 | 664485.9 | 083 |
| F | 6 | 9 | 884290. | 487 |
| NE | 7 | 10 | 1131700. | 255 |
| NA | 8 | 11 | 1426049. | 487 |
| MG | 9 | 12 | 1742772. | 487 |
| AL | 10 | 13 | 2090980. | 487 |
| SI | 11 | 14 | (2470000.) | 374 |
| P | 12 | 15 | 2876720. | 487 |
| S | 13 | 16 | (3310000.) | 374 |

1S2 2P ( 2P* ) 3P 3S 1

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | (96000.) | 374 |
| B | 2 | 5 | (196000.) | 374 |
| C | 3 | 6 | 327278.27 | 034 |
| N | 4 | 7 | 487607.4 | 824 |
| O | 5 | 8 | 683939.6 | 083 |
| F | 6 | 9 | 909284. | 171 |
| NE | 7 | 10 | 1165400. | 255 |
| NA | 8 | 11 | *1452428.* | 487 |
| MG | 9 | 12 | *1770430.* | 487 |
| AL | 10 | 13 | *2119440.* | 487 |
| SI | 11 | 14 | (2500000.) | 374 |

1S2 2P ( 2P* ) 3P 1S 0

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | (106000.) | 374 |
| B | 2 | 5 | (210000.) | 374 |
| C | 3 | 6 | 345095.43 | 034 |
| N | 4 | 7 | (511000.) | 374 |
| O | 5 | 8 | 707635.5 | 083 |
| F | 6 | 9 | 934633. | 487 |
| NE | 7 | 10 | (1193000.) | 374 |
| NA | 8 | 11 | 1481521. | 487 |

1S2 2P ( 2P* ) 3P 3P 0

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 92014.82 | 333 |
| B | 2 | 5 | (195600.) | 374 |
| C | 3 | 6 | 329685.38 | 034 |
| N | 4 | 7 | 494253.1 | 824 |
| O | 5 | 8 | 689400.2 | 083 |
| F | 6 | 9 | 915196. | 487 |
| NE | 7 | 10 | (1171500.) | 374 |
| NA | 8 | 11 | (1458000.) | 374 |
| MG | 9 | 12 | *1777628.* | 487 |
| AL | 10 | 13 | (2124000.) | 374 |

1S2 2P ( 2P* ) 3P 3P 1

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 92015.97 | 333 |
| B | 2 | 5 | (195600.) | 374 |
| C | 3 | 6 | 329706.47 | 034 |
| N | 4 | 7 | 494309.2 | 824 |
| O | 5 | 8 | 689514.4 | 083 |
| F | 6 | 9 | 915420. | 487 |
| NE | 7 | 10 | (1172000.) | 374 |
| NA | 8 | 11 | *1460104.* | 487 |
| MG | 9 | 12 | *1778745.* | 487 |
| AL | 10 | 13 | *2128300.* | 487 |

1S2 2P ( 2P* ) 3P 3P 2

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | 92018.10 | 333 |
| B | 2 | 5 | (195600.) | 374 |
| C | 3 | 6 | 329743.57 | 034 |
| N | 4 | 7 | 494402.0 | 824 |
| O | 5 | 8 | 689705.2 | 083 |
| F | 6 | 9 | 915770. | 487 |
| NE | 7 | 10 | 1172800. | 255 |
| NA | 8 | 11 | *1460988.* | 487 |
| MG | 9 | 12 | *1780057.* | 487 |
| AL | 10 | 13 | *2130180.* | 487 |

1S2 2P ( 2P* ) 3P 1P 1

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | (89300.) | 374 |
| B | 2 | 5 | 189126.6 | 487 |
| C | 3 | 6 | 319720.35 | 034 |
| N | 4 | 7 | 480884.2 | 824 |
| O | 5 | 8 | 672693.8 | 083 |
| F | 6 | 9 | 895287. | 487 |
| NE | 7 | 10 | 1149000. | 255 |
| NA | 8 | 11 | 1432991. | 487 |
| MG | 9 | 12 | 1748116. | 487 |
| AL | 10 | 13 | 2094730. | 487 |
| SI | 11 | 14 | (2473000.) | 374 |
| P | 12 | 15 | 2888690. | 487 |

1S2 2P ( 2P* ) 3P 3D 1

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | (92800.) | 374 |
| B | 2 | 5 | (192400.) | 374 |
| C | 3 | 6 | 323076.88 | 034 |
| N | 4 | 7 | 484498.2 | 824 |
| O | 5 | 8 | 677147.4 | 083 |
| F | 6 | 9 | 900442. | 487 |
| NE | 7 | 10 | (1155000.) | 374 |
| NA | 8 | 11 | *1439444.* | 487 |
| MG | 9 | 12 | *1755785.* | 487 |
| AL | 10 | 13 | *2101950.* | 487 |
| SI | 11 | 14 | (2482970.) | 375 |

TABLE V BERYLLIUM ISOELECTRONIC SEQUENCE (cont.)

1S2 2P ( 2P* ) 3P 3D 2

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | (92800.) | 374 |
| B | 2 | 5 | (192400.) | 374 |
| C | 3 | 6 | 323101.36 | 034 |
| N | 4 | 7 | 484594.9 | 824 |
| O | 5 | 8 | 677345.2 | 083 |
| F | 6 | 9 | 900785. | 487 |
| NE | 7 | 10 | (1155500.) | 374 |
| NA | 8 | 11 | *1440290.* | 487 |
| MG | 9 | 12 | *1756545.* | 487 |
| AL | 10 | 13 | *2103560.* | 487 |
| SI | 11 | 14 | (2484510.) | 375 |

1S2 2P ( 2P* ) 3P 3D 3

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | (92800.) | 374 |
| B | 2 | 5 | (192400.) | 374 |
| C | 3 | 6 | 323140.33 | 034 |
| N | 4 | 7 | 484746.2 | 824 |
| O | 5 | 8 | 677661.7 | 083 |
| F | 6 | 9 | 901397. | 487 |
| NE | 7 | 10 | 1155900. | 255 |
| NA | 8 | 11 | *1441910.* | 487 |
| MG | 9 | 12 | *1759045.* | 487 |
| AL | 10 | 13 | *2107290.* | 487 |
| SI | 11 | 14 | *2486810.* | 487 |
| P | 12 | 15 | *2897300.* | 487 |

1S2 2P ( 2P* ) 3P 1D 2

| | | | | |
|---|---|---|---|---|
| BE | 1 | 4 | (94800.) | 374 |
| B | 2 | 5 | (198600.) | 374 |
| C | 3 | 6 | 333118.21 | 034 |
| N | 4 | 7 | 499705.9 | 824 |
| O | 5 | 8 | 697170.2 | 083 |
| F | 6 | 9 | 925393. | 487 |
| NE | 7 | 10 | (1184000.) | 374 |
| NA | 8 | 11 | 1474598. | 487 |
| MG | 9 | 12 | 1795868. | 487 |
| AL | 10 | 13 | 2148320. | 487 |
| SI | 11 | 14 | 2532140. | 487 |
| P | 12 | 15 | 2947770. | 487 |
| S | 13 | 16 | (3395000.) | 374 |
| CL | 14 | 17 | (3875000.) | 374 |
| AR | 15 | 18 | (4387000.) | 374 |

TABLE V BERYLLIUM ISOELECTRONIC SEQUENCE (cont.)

| 1S2 | | | 2P2( ) | 1D 2 |
|---|---|---|---|---|
| BE | 1 | 4 | 56882.42 | 333 |
| B | 2 | 5 | 102362.1 | 487 |
| C | 3 | 6 | 145876.13 | 034 |
| N | 4 | 7 | 188882.5 | 824 |
| O | 5 | 8 | 231721.4 | 083 |
| F | 6 | 9 | 274597. | 487 |
| NE | 7 | 10 | *300000.* | 255 |
| NE | 7 | 10 | 317500. | 374 |
| NA | 8 | 11 | 361046. | 487 |
| MG | 9 | 12 | 404744. | 487 |
| AL | 10 | 13 | 448840. | 487 |
| SI | 11 | 14 | *493400.* | 487 |
| P | 12 | 15 | 538190. | 487 |
| S | 13 | 16 | (582600.) | 374 |
| CL | 14 | 17 | (626500.) | 374 |
| AR | 15 | 18 | (669300.) | 374 |

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TABLE VI

TRANSITIONS - BERYLLIUM ISOELECTRONIC SEQUENCE

| | | Be I | B II | C III | N IV | O V | F VI | Ne VII | Na VIII |
|---|---|---|---|---|---|---|---|---|---|
| $2s^2 - 2s2p$ | $^1S_0 - {}^1P^0_1$ | 2349.33 | 1362.46 | 977.02 | 765.15 | 629.73 | 535.21 | 465.22 | 411.15 |
| $2s2p - 2s3s$ | $^1P^0_1 - {}^1S_0$ | 8256.34 | 1598.74 | 690.52 | 387.36 | 248.46 | 173.14 | 127.64 | 98.08 |
| $2s2p - 2s3d$ | $^3P^0_2 - {}^3D_3$ | 2495.48 | 882.67 | 491.16 | 283.57 | 192.90 | 139.90 | 106.18 | 83.39 |
| | $^1P^0_1 - {}^1D_2$ | 4573.95 | 1230.16 | 574.28 | 335.05 | 220.35 | 156.25 | 116.65 | 90.54 |
| $2s2p - 2s4s$ | $^3P^0_2 - {}^3S_1$ | 2351.55 | 775.27 | 389.09 | 232.22 | 156.23 | 112.05 | 84.84 | 65.73 |
| | $^1P^0_1 - {}^1S_0$ | 4409.17 | 1057.78 | 477.62 | (269.46) | 174.56 | 123.33 | (91.61) | 70.74 |
| $2s2p - 2p3p$ | $^3P^0_2 - {}^3S_1$ | (1351.01) | (630.34) | 363.86 | 237.99 | 166.24 | 123.18 | 94.99 | 75.51 |
| | $^3P^0_2 - {}^3P_2$ | 1427.82 | (631.94) | 360.63 | 234.20 | 164.66 | 122.20 | 94.33 | 75.03 |
| | $^3P^0_2 - {}^3D_3$ | (1412.06) | (644.98) | 369.42 | 239.62 | 167.99 | 124.38 | 95.86 | 76.12 |
| | $^1P^0_1 - {}^1S_0$ | (1576.42) | (732.05) | 411.96 | 262.95 | 182.20 | 133.73 | (102.24) | 80.76 |
| | $^1P^0_1 - {}^1D_2$ | (1914.44) | (798.70) | 433.34 | 270.99 | 185.74 | 135.40 | (103.19) | 81.21 |
| $2s2p - 2p^2$ | $^1P^0_1 - {}^1D_2$ | 6984.67 | 3452.39 | 2297.53 | 1718.55 | 1371.30 | 1139.52 | (975.15) | 848.73 |
| $2s3s - 2s3p$ | $^1S_0 - {}^1P^0_1$ | 18148.49 | 12260.91 | 8502.66 | 6382.52 | 5115.72 | 4266.03 | 3731.34 | 3183.19 |
| $2s3s - 2s4p$ | $^1S_0 - {}^1P^0_1$ | 8092.29 | 2573.74 | 1329.19 | 846.21 | 566.24 | 410.75 | 311.33 | 243.55 |
| $2s3s - 2s5p$ | $^1S_0 - {}^1P^0_1$ | 6475.33 | (2166.66) | 1040.72 | 619.66 | 414.61 | 298.49 | (224.52) | 173.58 |
| $2s3s - 2p3s$ | $^1S_0 - {}^1P^0_1$ | (3659.56) | (2219.55) | 1591.44 | 1188.01 | 968.90 | 834.04 | 750.19 | 612.56 |

Note: Transitions in Angstroms. ( ) indicates prediction.

TABLE VI

TRANSITIONS - BERYLLIUM ISOELECTRONIC SEQUENCE (continued)

| | | Mg IX | Al X | Si XI | P XII | S XIII | Cl XIV | Ar XV |
|---|---|---|---|---|---|---|---|---|
| $2s^2$ - 2s2p | $^1S_0$ - $^1P^0_1$ | 368.07 | 332.89 | 303.31 | 278.68 | (258.40) | (240.96) | (225.23) |
| 2s2p - 2s3s | $^1P^0_1$ - $^1S_0$ | 77.74 | 63.13 | 52.31 | 44.04 | (37.59) | (32.47) | (28.32) |
| 2s2p - 2s3d | $^3P^0_2$ - $^3D_3$ | 67.24 | 55.38 | 46.40 | 39.45 | (34.01) | (29.60) | (25.98) |
| | $^1P^0_1$ - $^1D_2$ | 72.31 | 59.11 | 49.22 | 41.64 | (35.66) | (30.88) | (27.01) |
| 2s2p - 2s4s | $^3P^0_2$ - $^3S_1$ | (52.50) | (42.70) | | | | | |
| | $^1P^0_1$ - $^1S_0$ | (56.15) | (45.49) | | | | | |
| 2s2p - 2p3p | $^3P^0_2$ - $^3S_1$ | 61.49 | 51.04 | (43.04) | | | | |
| | $^3P^0_2$ - $^3P_2$ | 61.13 | 50.76 | | | | | |
| | $^3P^0_2$ - $^3D_3$ | 61.92 | 51.36 | 43.29 | 36.98 | | | |
| | $^1P^0_1$ - $^1S_0$ | | | | | | | |
| | $^1P^0_1$ - $^1D_2$ | 65.61 | 54.11 | 45.40 | 38.62 | (33.24) | (28.90) | (25.36) |
| 2s2p - $2p^2$ | $^1P^0_1$ - $^1D_2$ | 751.56 | 673.67 | 610.87 | 557.57 | (511.25) | (472.81) | (443.85) |
| 2s3s - 2s3p | $^1S_0$ - $^1P^0_1$ | 2815.00 | 2530.36 | 2295.68 | 2062.28 | (1834.86) | (1629.75) | (1457.73) |
| 2s3s - 2s4p | $^1S_0$ - $^1P^0_1$ | 195.85 | (161.38) | (135.22) | | | | |
| 2s3s - 2s5p | $^1S_0$ - $^1P^0_1$ | (136.59) | (108.65) | | | | | |
| 2s3s - 2p3s | $^1S_0$ - $^1P^0_1$ | 541.43 | 483.91 | (383.14) | 404.09 | (331.12) | | |

TABLE VII BORON ISOELECTRONIC SEQUENCE

1S2 2S2( ) 2PG 2P* 2

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | 15.15 | 62 |
| C | 02 | 06 | 64.00 | 287 |
| N | 3 | 7 | 174.5 | 487 |
| O | 4 | 8 | 385.9 | 086 |
| F | 5 | 9 | 746. | 487 |
| NE | 6 | 10 | 1310. | 071 |
| NA | 7 | 11 | 2139. | 487 |
| MG | 8 | 12 | 3304. | 487 |
| AL | 9 | 13 | 4890. | 487 |
| SI | 10 | 14 | 6990. | 487 |
| P | 11 | 15 | 9700. | 487 |
| S | 12 | 16 | (13130.) | 374 |
| CL | 13 | 17 | *20000.* | 269 |
| CL | 13 | 17 | (17400.) | 374 |
| AR | 14 | 18 | (22630.) | 374 |
| K | 15 | 19 | (28970.) | 374 |
| CA | 16 | 20 | (36550.) | 374 |

1S2 2S2( ) 3S 2S 1

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | 40039.52 | 62 |
| C | 02 | 06 | 116538.08 | 287 |
| N | 3 | 7 | 221302.4 | 487 |
| O | 4 | 8 | 357614.3 | 086 |
| F | 5 | 9 | 524751. | 487 |
| NE | 6 | 10 | 722610. | 487 |
| NA | 7 | 11 | 951347. | 487 |
| MG | 8 | 12 | 1210689. | 487 |
| AL | 9 | 13 | 1501020. | 487 |
| SI | 10 | 14 | (1822000.) | 374 |
| P | 11 | 15 | 2174060. | 487 |
| S | 12 | 16 | (2556000.) | 374 |
| CL | 13 | 17 | (2970000.) | 374 |
| AR | 14 | 18 | (3414000.) | 374 |

1S2 2S2( ) 3P 2P* 1

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | 48611.69 | 62 |
| C | 02 | 06 | 131724.80 | 287 |
| N | 3 | 7 | 245665.7 | 487 |
| O | 4 | 8 | 390161.2 | 086 |
| F | 5 | 9 | 565367. | 487 |
| NE | 6 | 10 | *771234.1* | 071 |
| NA | 7 | 11 | (1078000.) | 374 |
| MG | 8 | 12 | (1275000.) | 374 |
| AL | 9 | 13 | (1573000.) | 374 |

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2( ) 3P 2P* 2

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | 48613.47 | 62 |
| C | 02 | 06 | 131735.95 | 287 |
| N | 3 | 7 | 245701.7 | 487 |
| O | 4 | 8 | 390248.0 | 086 |
| F | 5 | 9 | 565544. | 487 |
| NE | 6 | 10 | *771556.7* | 071 |
| NA | 7 | 11 | 1008418. | 487 |
| MG | 8 | 12 | (1276000.) | 374 |
| AL | 9 | 13 | (1575000.) | 374 |

1S2 2S2( ) 4S 2S 1

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | 55010.08 | 62 |
| C | 02 | 06 | 157234.50 | 287 |
| N | 3 | 7 | 301088.2 | 487 |
| O | 4 | 8 | 485821.7 | 086 |
| F | 5 | 9 | 712936. | 487 |
| NE | 6 | 10 | (983000.) | 374 |
| NA | 7 | 11 | 1294914. | 487 |
| MG | 8 | 12 | 1647879. | 487 |
| AL | 9 | 13 | (2043000.) | 374 |
| SI | 10 | 14 | (2481000.) | 374 |

1S2 2S2( ) 5S 2S 1

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | 60146.24 | 62 |
| C | 02 | 06 | 173348.27 | 287 |
| N | 3 | 7 | 333713.1 | 487 |
| O | 4 | 8 | 539368. | 086 |
| F | 5 | 9 | (791500.) | 374 |
| NE | 6 | 10 | (1090000.) | 374 |

1S2 2S 2P2( ) 2S 1

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | 63561. | 487 |
| C | 02 | 06 | 96494.17 | 287 |
| N | 3 | 7 | 131003.5 | 487 |
| O | 4 | 8 | 164366.4 | 086 |
| F | 5 | 9 | 197565. | 487 |
| NE | 6 | 10 | 230853. | 071 |
| NA | 7 | 11 | 264400. | 487 |
| MG | 8 | 12 | 298283. | 487 |
| AL | 9 | 13 | 332650. | 487 |
| SI | 10 | 14 | 367650. | 487 |
| P | 11 | 15 | 403330. | 487 |
| S | 12 | 16 | (440500.) | 374 |
| CL | 13 | 17 | (479000.) | 374 |
| AR | 14 | 18 | (519500.) | 374 |

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

| 1S2 2S | | | 2P2( ) | 2P 1 |
|---|---|---|---|---|
| B | 1 | 5 | 72535. | 487 |
| C | 02 | 06 | 110624.60 | 287 |
| N | 3 | 7 | 145876.1 | 487 |
| O | 4 | 8 | 180480.8 | 086 |
| F | 5 | 9 | 214881. | 487 |
| NE | 6 | 10 | 249292. | 487 |
| NA | 7 | 11 | 283869. | 487 |
| MG | 8 | 12 | 318747. | 487 |
| AL | 9 | 13 | 353960. | 487 |
| SI | 10 | 14 | 389740. | 487 |
| P | 11 | 15 | 425820. | 487 |
| S | 12 | 16 | (460000.) | 374 |
| CL | 13 | 17 | (495000.) | 374 |
| AR | 14 | 18 | (530000.) | 374 |

| 1S2 2S | | | 2P2( ) | 2P 2 |
|---|---|---|---|---|
| B | 1 | 5 | 72547. | 487 |
| C | 02 | 06 | 110665.99 | 287 |
| N | 3 | 7 | 145986.5 | 487 |
| O | 4 | 8 | 180724.2 | 086 |
| F | 5 | 9 | 215348. | 487 |
| NE | 6 | 10 | 250112. | 487 |
| NA | 7 | 11 | 285189. | 487 |
| MG | 8 | 12 | 320742. | 487 |
| AL | 9 | 13 | 356950. | 487 |
| SI | 10 | 14 | 394000. | 487 |
| P | 11 | 15 | 431650. | 487 |
| S | 12 | 16 | (467000.) | 374 |
| CL | 13 | 17 | (504000.) | 374 |
| AR | 14 | 18 | (540000.) | 374 |

| 1S2 | | | 2P3( ) | 2P* 1 |
|---|---|---|---|---|
| B | 1 | 5 | (111100.) | 374 |
| C | 02 | 06 | 168729.96 | 287 |
| N | 3 | 7 | 230404.5 | 487 |
| O | 4 | 8 | 289015.4 | 086 |
| F | 5 | 9 | 347418. | 487 |
| NE | 6 | 10 | *405984.* | 071 |
| NA | 7 | 11 | 465017. | 487 |
| MG | 8 | 12 | 524339. | 487 |
| AL | 9 | 13 | 584150. | 487 |
| SI | 10 | 14 | 644560. | 487 |
| P | 11 | 15 | (703300.) | 374 |
| S | 12 | 16 | (762800.) | 374 |
| CL | 13 | 17 | (822000.) | 374 |

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

| 1S2 | | | 2P3( ) | 2P* 2 |
|---|---|---|---|---|
| B | 1 | 5 | (111200.) | 374 |
| C | 02 | 06 | 168748.73 | 287 |
| N | 3 | 7 | 230408.6 | 487 |
| O | 4 | 8 | 289023.5 | 086 |
| F | 5 | 9 | 347438. | 487 |
| NE | 6 | 10 | *406056.* | 071 |
| NA | 7 | 11 | 465111. | 487 |
| MG | 8 | 12 | 524486. | 487 |
| AL | 9 | 13 | 584390. | 487 |
| SI | 10 | 14 | 644940. | 487 |
| P | 11 | 15 | (703800.) | 374 |
| S | 12 | 16 | (763500.) | 374 |
| CL | 13 | 17 | (823000.) | 374 |

| 1S2 | | | 2P3( ) | 2D* 2 |
|---|---|---|---|---|
| B | 1 | 5 | (99800.) | 374 |
| C | 02 | 06 | 150467.12 | 287 |
| N | 3 | 7 | 203088.9 | 487 |
| O | 4 | 8 | 255184.9 | 086 |
| F | 5 | 9 | 307273. | 487 |
| NE | 6 | 10 | (359700.) | 374 |
| NA | 7 | 11 | 412395. | 487 |
| MG | 8 | 12 | 465738. | 487 |
| AL | 9 | 13 | 519740. | 487 |
| SI | 10 | 14 | 574600. | 487 |
| P | 11 | 15 | (628600.) | 374 |
| S | 12 | 16 | (683400.) | 374 |

| 1S2 | | | 2P3( ) | 2D* 3 |
|---|---|---|---|---|
| B | 1 | 5 | (99800.) | 374 |
| C | 02 | 06 | 150462.01 | 287 |
| N | 3 | 7 | 203072.2 | 487 |
| O | 4 | 8 | 255155.9 | 086 |
| F | 5 | 9 | 307226. | 487 |
| NE | 6 | 10 | (359600.) | 374 |
| NA | 7 | 11 | 412311. | 487 |
| MG | 8 | 12 | 465598. | 487 |
| AL | 9 | 13 | 519560. | 487 |
| SI | 10 | 14 | 574360. | 487 |
| P | 11 | 15 | (628300.) | 374 |
| S | 12 | 16 | (683000.) | 374 |

| 1S2 | | | 2P2( 1D ) 3S | 2D 2 |
|---|---|---|---|---|
| N | 3 | 7 | (421000.) | 374 |
| O | 4 | 8 | 600092. | 487 |
| F | 5 | 9 | 811075. | 487 |
| NE | 6 | 10 | (1055000.) | 374 |
| NA | 7 | 11 | 1331137. | 487 |
| MG | 8 | 12 | 1638646. | 487 |
| AL | 9 | 13 | (1979000.) | 374 |

1S2 2P2( 1D ) 3S 2D 3

| | | | | |
|---|---|---|---|---|
| N | 3 | 7 | (421000.) | 374 |
| O | 4 | 8 | 600106. | 487 |
| F | 5 | 9 | 811075. | 487 |
| NE | 6 | 10 | (1055000.) | 374 |
| NA | 7 | 11 | 1331974. | 487 |
| MG | 8 | 12 | 1638646. | 487 |
| AL | 9 | 13 | (1979000.) | 374 |

1S2 2P2( 1D ) 3P 2D* 2

| | | | | |
|---|---|---|---|---|
| O | 4 | 8 | (633000.) | 374 |
| F | 5 | 9 | *854971.* | 487 |
| NE | 6 | 10 | (1108000.) | 374 |
| NA | 7 | 11 | 1392764. | 487 |
| MG | 8 | 12 | 1708860. | 487 |
| AL | 9 | 13 | 2056120. | 487 |
| SI | 10 | 14 | (2435000.) | 374 |
| P | 11 | 15 | (2845000.) | 374 |

1S2 2P2( 1D ) 3P 2D* 3

| | | | | |
|---|---|---|---|---|
| O | 4 | 8 | (633000.) | 374 |
| F | 5 | 9 | 854971. | 487 |
| NE | 6 | 10 | (1108000.) | 374 |
| NA | 7 | 11 | 1392764. | 487 |
| MG | 8 | 12 | 1708860. | 487 |
| AL | 9 | 13 | 2056120. | 487 |
| SI | 10 | 14 | (2435000.) | 374 |
| P | 11 | 15 | (2845000.) | 374 |

1S2 2P2( 1D ) 3P 2F* 3

| | | | | |
|---|---|---|---|---|
| N | 3 | 7 | (436500.) | 374 |
| O | 4 | 8 | 624882. | 487 |
| F | 5 | 9 | 844112. | 487 |
| NE | 6 | 10 | (1095000.) | 374 |
| NA | 7 | 11 | 1377822. | 487 |
| MG | 8 | 12 | 1691070. | 487 |
| AL | 9 | 13 | (2036000.) | 374 |

1S2 2P2( 1D ) 3P 2F* 4

| | | | | |
|---|---|---|---|---|
| N | 3 | 7 | (436500.) | 374 |
| O | 4 | 8 | 624882. | 487 |
| F | 5 | 9 | 844266. | 487 |
| NE | 6 | 10 | (1095000.) | 374 |
| NA | 7 | 11 | 1378295. | 487 |
| MG | 8 | 12 | 1691070. | 487 |
| AL | 9 | 13 | (2036000.) | 374 |

1S2 2P2( 1D ) 3D 2P 1

| | | | | |
|---|---|---|---|---|
| N | 3 | 7 | (455000.) | 374 |
| O | 4 | 8 | 653411. | 487 |
| F | 5 | 9 | 882930. | 487 |
| NE | 6 | 10 | (1142200.) | 374 |
| NA | 7 | 11 | 1432135. | 487 |
| MG | 8 | 12 | 1753323. | 691 |
| AL | 9 | 13 | (2104000.) | 374 |

1S2 2P2( 1D ) 3D 2P 2

| | | | | |
|---|---|---|---|---|
| N | 3 | 7 | (455000.) | 374 |
| O | 4 | 8 | 653328. | 487 |
| F | 5 | 9 | 883083. | 487 |
| NE | 6 | 10 | (1142500.) | 374 |
| NA | 7 | 11 | 1432606. | 487 |
| MG | 8 | 12 | 1754288. | 691 |
| AL | 9 | 13 | (2106000.) | 374 |

1S2 2S 2P ( 3P* ) 3S 4P* 1

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (77100.) | 374 |
| C | 02 | 06 | 166967.56 | 287 |
| N | 3 | 7 | 287535.6 | 487 |
| O | 4 | 8 | 438849.0 | 086 |
| F | 5 | 9 | 620810. | 487 |
| NE | 6 | 10 | (835100.) | 374 |
| NA | 7 | 11 | *1076584.* | 487 |
| MG | 8 | 12 | *1352123.* | 487 |
| AL | 9 | 13 | *1657690.* | 487 |
| SI | 10 | 14 | *1993860.* | 487 |
| P | 11 | 15 | *2379730.* | 487 |

1S2 2S 2P ( 3P* ) 3S 4P* 2

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (77100.) | 374 |
| C | 02 | 06 | 166991.16 | 287 |
| N | 3 | 7 | 287598.1 | 487 |
| O | 4 | 8 | 438983.9 | 086 |
| F | 5 | 9 | 621067. | 487 |
| NE | 6 | 10 | 835595. | 071 |
| NA | 7 | 11 | *1077316.* | 487 |
| MG | 8 | 12 | *1353279.* | 487 |
| AL | 9 | 13 | *1659350.* | 487 |
| SI | 10 | 14 | *1996180.* | 487 |
| P | 11 | 15 | *2376130.* | 487 |

1S2 2S 2P ( 3P* ) 3S 4P* 3

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (77100.) | 374 |
| C | 02 | 06 | 167036.14 | 287 |
| N | 3 | 7 | 287713.9 | 487 |
| O | 4 | 8 | 439230.9 | 086 |
| F | 5 | 9 | 621535. | 487 |
| NE | 6 | 10 | 836407. | 071 |
| NA | 7 | 11 | *1078646.* | 487 |
| MG | 8 | 12 | *1355296.* | 487 |
| AL | 9 | 13 | *1662340.* | 487 |
| SI | 10 | 14 | *2000570.* | 487 |
| P | 11 | 15 | *2369930.* | 487 |

1S2 2S 2P ( 3P* ) 3S 2P* 1

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (84800.) | 374 |
| C | 02 | 06 | 177775.02 | 287 |
| N | 3 | 7 | 297150.2 | 487 |
| O | 4 | 8 | 452806.6 | 086 |
| F | 5 | 9 | 638856. | 487 |
| NE | 6 | 10 | (854800.) | 374 |
| NA | 7 | 11 | 1103222. | 487 |
| MG | 8 | 12 | 1381466. | 487 |
| AL | 9 | 13 | 1690880. | 487 |
| SI | 10 | 14 | (2032000.) | 374 |
| P | 11 | 15 | 2410070. | 487 |
| P | 11 | 15 | (2405000.) | 374 |

1S2 2S 2P ( 3P* ) 3S 2P* 2

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (84800.) | 374 |
| C | 02 | 06 | 177793.97 | 287 |
| N | 3 | 7 | 297263.1 | 487 |
| O | 4 | 8 | 453071.5 | 086 |
| F | 5 | 9 | 639365. | 487 |
| NE | 6 | 10 | (855800.) | 374 |
| NA | 7 | 11 | 1104620. | 487 |
| MG | 8 | 12 | 1383731. | 487 |
| AL | 9 | 13 | 1694110. | 487 |
| SI | 10 | 14 | 2035810. | 487 |
| P | 11 | 15 | 2410070. | 487 |

1S2 2S 2P ( 1P* ) 3S 2P* 1

| | | | | |
|---|---|---|---|---|
| C | 2 | 6 | (235000.) | 374 |
| N | 3 | 7 | (359000.) | 374 |
| O | 4 | 8 | 518684. | 487 |
| F | 5 | 9 | 712755. | 487 |
| NE | 6 | 10 | (940000.) | 374 |
| NA | 7 | 11 | 1198287. | 487 |
| MG | 8 | 12 | 1486995. | 487 |
| AL | 9 | 13 | 1807020. | 487 |
| SI | 10 | 14 | 2158290. | 487 |
| P | 11 | 15 | 2541040. | 487 |
| S | 12 | 16 | (2957000.) | 374 |

1S2 2S 2P ( 1P* ) 3S 2P* 2

| | | | | |
|---|---|---|---|---|
| C | 2 | 6 | (235000.) | 374 |
| N | 3 | 7 | (359000.) | 374 |
| O | 4 | 8 | 518690. | 487 |
| F | 5 | 9 | 712755. | 487 |
| NE | 6 | 10 | (940000.) | 374 |
| NA | 7 | 11 | 1198287. | 487 |
| MG | 8 | 12 | 1486995. | 487 |
| AL | 9 | 13 | 1807020. | 487 |
| SI | 10 | 14 | 2158290. | 487 |
| P | 11 | 15 | 2541040. | 487 |
| S | 12 | 16 | (2957000.) | 374 |

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P ( 3P* ) 3P 4S 2

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (86200.) | 374 |
| C | 02 | 06 | 184691.41 | 287 |
| N | 3 | 7 | 314224.0 | 487 |
| O | 4 | 8 | 474478.1 | 086 |
| F | 5 | 9 | 665912. | 487 |
| NE | 6 | 10 | (888000.) | 374 |
| NA | 7 | 11 | (1141000.) | 374 |

1S2 2S 2P ( 3P* ) 3P 2S 1

| | | | | |
|---|---|---|---|---|
| C | 2 | 6 | (199000.) | 374 |
| N | 3 | 7 | 327056.8 | 487 |
| O | 4 | 8 | 492890.9 | 086 |
| F | 5 | 9 | 687806. | 487 |
| NE | 6 | 10 | 900408. | 487 |
| NA | 7 | 11 | 1172339. | 487 |
| MG | 8 | 12 | 1460911. | 487 |
| AL | 9 | 13 | 1780950. | 487 |
| SI | 10 | 14 | (2140000.) | 374 |

1S2 2S 2P ( 1P* ) 3P 2S 1

| | | | | |
|---|---|---|---|---|
| N | 3 | 7 | (381000.) | 374 |
| O | 4 | 8 | 554461. | 487 |
| F | 5 | 9 | 760342. | 487 |
| NE | 6 | 10 | (994000.) | 374 |
| NA | 7 | 11 | 1258878. | 487 |
| MG | 8 | 12 | 1556517. | 487 |
| AL | 9 | 13 | (1883000.) | 374 |

1S2 2S 2P ( 3P* ) 3P 2P 1

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (86000.) | 374 |
| C | 02 | 06 | 182024.29 | 287 |
| N | 3 | 7 | 309132.6 | 487 |
| O | 4 | 8 | 467229.3 | 086 |
| F | 5 | 9 | 656208. | 487 |
| NE | 6 | 10 | 878852. | 487 |
| NE | 6 | 10 | (876100.) | 374 |
| NA | 7 | 11 | 1126810. | 487 |
| MG | 8 | 12 | 1408371. | 487 |
| AL | 9 | 13 | 1720900. | 487 |
| SI | 10 | 14 | (2064400.) | 374 |
| P | 11 | 15 | (2439000.) | 374 |
| S | 12 | 16 | (2845000.) | 374 |

1S2 2S 2P ( 3P* ) 3P 2P 2

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (86000.) | 374 |
| C | 02 | 06 | 182043.84 | 287 |
| N | 3 | 7 | 309185.8 | 487 |
| O | 4 | 8 | 467344.9 | 086 |
| F | 5 | 9 | 656436. | 487 |
| NE | 6 | 10 | 878852. | 487 |
| NE | 6 | 10 | (876500.) | 374 |
| NA | 7 | 11 | 1127431. | 487 |
| MG | 8 | 12 | 1409401. | 487 |
| AL | 9 | 13 | 1722400. | 487 |
| SI | 10 | 14 | 2066600. | 487 |
| P | 11 | 15 | (2442000.) | 374 |
| S | 12 | 16 | (2849000.) | 374 |

TABLE VII   BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P ( 1P* ) 3P 2P 1

| | | | | |
|---|---|---|---|---|
| C | 2 | 6 | (237000.) | 374 |
| N | 3 | 7 | 377591. | 487 |
| O | 4 | 8 | 549792. | 487 |
| F | 5 | 9 | 753529. | 487 |
| NE | 6 | 10 | (987300.) | 374 |
| NA | 7 | 11 | 1253353. | 487 |
| MG | 8 | 12 | 1549955. | 487 |
| AL | 9 | 13 | 1878390. | 487 |
| SI | 10 | 14 | (2238000.) | 374 |

1S2 2S 2P ( 1P* ) 3P 2P 2

| | | | | |
|---|---|---|---|---|
| C | 2 | 6 | (237000.) | 374 |
| N | 3 | 7 | 377608. | 487 |
| O | 4 | 8 | 549855. | 487 |
| F | 5 | 9 | 753656. | 487 |
| NE | 6 | 10 | (987600.) | 374 |
| NA | 7 | 11 | 1253779. | 487 |
| MG | 8 | 12 | 1550564. | 487 |
| AL | 9 | 13 | 1878390. | 487 |
| AL | 9 | 13 | (1879500.) | 374 |
| SI | 10 | 14 | (2240000.) | 374 |

1S2 2S 2P ( 3P* ) 3P 2D 2

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (86000.) | 374 |
| C | 02 | 06 | 188581.68 | 287 |
| N | 3 | 7 | 320977.4 | 487 |
| O | 4 | 8 | 482666.1 | 086 |
| F | 5 | 9 | 675932. | 487 |
| NE | 6 | 10 | 906373. | 487 |
| NE | 6 | 10 | (900000.) | 374 |
| NA | 7 | 11 | 1154779. | 487 |
| MG | 8 | 12 | 1440561. | 487 |
| AL | 9 | 13 | 1757500. | 487 |
| SI | 10 | 14 | (2105000.) | 374 |
| P | 11 | 15 | (2483000.) | 374 |

1S2 2S 2P ( 3P* ) 3P 2D 3

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (86000.) | 374 |
| C | 02 | 06 | 188615.50 | 287 |
| N | 3 | 7 | 321065.8 | 487 |
| O | 4 | 8 | 482921.6 | 086 |
| F | 5 | 9 | 676422. | 487 |
| NE | 6 | 10 | 906373. | 487 |
| NE | 6 | 10 | (900800.) | 374 |
| NA | 7 | 11 | 1156180. | 487 |
| MG | 8 | 12 | 1442836. | 487 |
| AL | 9 | 13 | 1760970. | 487 |
| SI | 10 | 14 | 2110260. | 487 |
| P | 11 | 15 | (2490000.) | 374 |

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P ( 1P* ) 3P 2D 2

| | | | | |
|---|---|---|---|---|
| C | 2 | 6 | (231000.) | 374 |
| N | 3 | 7 | 373342. | 487 |
| O | 4 | 8 | 547311. | 487 |
| F | 5 | 9 | 751406. | 487 |
| NE | 6 | 10 | (986200.) | 374 |
| NA | 7 | 11 | 1251674. | 487 |
| MG | 8 | 12 | 1548027. | 487 |
| AL | 9 | 13 | 1875340. | 487 |
| SI | 10 | 14 | (2233000.) | 374 |
| P | 11 | 15 | (2621000.) | 374 |

1S2 2S 2P ( 1P* ) 3P 2D 3

| | | | | |
|---|---|---|---|---|
| C | 2 | 6 | (231000.) | 374 |
| N | 3 | 7 | 373376. | 487 |
| O | 4 | 8 | 547336. | 487 |
| F | 5 | 9 | 751452. | 487 |
| NE | 6 | 10 | (986400.) | 374 |
| NA | 7 | 11 | 1252014. | 487 |
| MG | 8 | 12 | 1548851. | 487 |
| AL | 9 | 13 | 1876710. | 487 |
| SI | 10 | 14 | (2235000.) | 374 |
| P | 11 | 15 | (2624000.) | 374 |

1S2 2S 2P ( 3P* ) 3D 4P* 1

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (92070.) | 374 |
| C | 02 | 06 | 198879.44 | 287 |
| N | 3 | 7 | 336303.1 | 487 |
| O | 4 | 8 | 504282.3 | 086 |
| F | 5 | 9 | 702931. | 487 |
| NE | 6 | 10 | (932150.) | 374 |
| NA | 7 | 11 | *1192528.* | 487 |
| MG | 8 | 12 | *1485639.* | 487 |
| AL | 9 | 13 | *1809210.* | 487 |

1S2 2S 2P ( 3P* ) 3D 4P* 2

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (92070.) | 374 |
| C | 02 | 06 | 198865.68 | 287 |
| N | 3 | 7 | 336268.0 | 487 |
| O | 4 | 8 | 504208.9 | 086 |
| F | 5 | 9 | 702789. | 487 |
| NE | 6 | 10 | (931900.) | 374 |
| NA | 7 | 11 | *1192185.* | 487 |
| MG | 8 | 12 | *1485153.* | 487 |
| AL | 9 | 13 | *1808530.* | 487 |

1S2 2S 2P ( 3P* ) 3D 4P* 3

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (92070.) | 374 |
| C | 02 | 06 | 198844.43 | 287 |
| N | 3 | 7 | 336213.4 | 487 |
| O | 4 | 8 | 504095.7 | 086 |
| F | 5 | 9 | 702580. | 487 |
| NE | 6 | 10 | (931600.) | 374 |
| NA | 7 | 11 | *1191664.* | 487 |
| MG | 8 | 12 | *1484449.* | 487 |
| AL | 9 | 13 | *1807490.* | 487 |
| SI | 10 | 14 | *2161950.* | 487 |
| P | 11 | 15 | *2547290.* | 487 |

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P ( 3P* ) 3D 2P* 1

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (93840.) | 374 |
| C | 02 | 06 | 202204.95 | 287 |
| N | 3 | 7 | 342763.7 | 487 |
| O | 4 | 8 | 514371.3 | 086 |
| F | 5 | 9 | 718691. | 487 |
| NE | 6 | 10 | (952600.) | 374 |
| NA | 7 | 11 | 1217955. | 487 |
| MG | 8 | 12 | 1514266. | 487 |
| AL | 9 | 13 | 1842220. | 487 |
| SI | 10 | 14 | 2201770. | 487 |
| P | 11 | 15 | 2593090. | 487 |
| S | 12 | 16 | (3017500.) | 374 |
| CL | 13 | 17 | (3476000.) | 374 |

1S2 2S 2P ( 3P* ) 3D 2P* 2

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (93840.) | 374 |
| C | 02 | 06 | 202180.28 | 287 |
| N | 3 | 7 | 342693.0 | 487 |
| O | 4 | 8 | 514220.4 | 086 |
| F | 5 | 9 | 718472. | 487 |
| NE | 6 | 10 | (952200.) | 374 |
| NA | 7 | 11 | 1217189. | 487 |
| MG | 8 | 12 | 1513099. | 487 |
| AL | 9 | 13 | 1840470. | 487 |
| SI | 10 | 14 | 2199190. | 487 |
| P | 11 | 15 | 2589460. | 487 |
| S | 12 | 16 | (3012500.) | 374 |
| CL | 13 | 17 | (3469000.) | 374 |

1S2 2S 2P ( 1P* ) 3D 2P* 1

| | | | | |
|---|---|---|---|---|
| N | 3 | 7 | (404800.) | 374 |
| O | 4 | 8 | 581721. | 487 |
| F | 5 | 9 | 793308. | 487 |
| NE | 6 | 10 | (1035000.) | 374 |
| NA | 7 | 11 | 1306468. | 487 |
| MG | 8 | 12 | 1610669. | 487 |
| AL | 9 | 13 | 1954710. | 487 |
| SI | 10 | 14 | (2349000.) | 374 |

1S2 2S 2P ( 1P* ) 3D 2P* 2

| | | | | |
|---|---|---|---|---|
| N | 3 | 7 | (404800.) | 374 |
| O | 4 | 8 | 581743. | 487 |
| F | 5 | 9 | 793308. | 487 |
| NE | 6 | 10 | (1035000.) | 374 |
| NA | 7 | 11 | 1306468. | 487 |
| MG | 8 | 12 | 1610669. | 487 |
| AL | 9 | 13 | 1954710. | 487 |
| SI | 10 | 14 | (2349000.) | 374 |

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P ( 3P* ) 3D 2D* 2

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (93300.) | 374 |
| C | 02 | C6 | 198425.86 | 287 |
| N | 3 | 7 | 334542.2 | 487 |
| O | 4 | 8 | 501509.2 | 086 |
| F | 5 | 9 | 699293. | 487 |
| NE | 6 | 10 | (928000.) | 374 |
| NA | 7 | 11 | (1187612.) | 375 |
| MG | 8 | 12 | 1478358. | 487 |
| AL | 9 | 13 | 1800460. | 487 |
| SI | 10 | 14 | 2153680. | 487 |
| P | 11 | 15 | 2539140. | 487 |
| S | 12 | 16 | (2956500.) | 374 |
| CL | 13 | 17 | (3406500.) | 374 |
| AR | 14 | 18 | (3890000.) | 374 |

1S2 2S 2P ( 3P* ) 3D 2D* 3

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (93300.) | 374 |
| C | 02 | 06 | 198436.74 | 287 |
| N | 3 | 7 | 334568.9 | 487 |
| O | 4 | 8 | 501564.4 | 086 |
| F | 5 | 9 | 699389. | 487 |
| NE | 6 | 10 | (928150.) | 374 |
| NA | 7 | 11 | 1187885. | 487 |
| MG | 8 | 12 | 1478706. | 487 |
| AL | 9 | 13 | 1800910. | 487 |
| SI | 10 | 14 | 2154440. | 487 |
| P | 11 | 15 | 2540050. | 487 |
| S | 12 | 16 | (2958000.) | 374 |
| CL | 13 | 17 | (3408000.) | 374 |
| AR | 14 | 18 | (3892000.) | 374 |

1S2 2S 2P ( 1P* ) 3D 2D* 2

| | | | | |
|---|---|---|---|---|
| C | 2 | 6 | (248600.) | 374 |
| N | 3 | 7 | 396574.9 | 487 |
| O | 4 | 8 | 575819. | 487 |
| F | 5 | 9 | 787725. | 487 |
| NE | 6 | 10 | (1029900.) | 374 |
| NA | 7 | 11 | 1303445. | 487 |
| MG | 8 | 12 | 1607872. | 487 |
| AL | 9 | 13 | 1943380. | 487 |
| SI | 10 | 14 | 2310230. | 487 |
| P | 11 | 15 | 2707510. | 487 |
| S | 12 | 16 | (3136500.) | 374 |
| CL | 13 | 17 | (3597000.) | 374 |
| AR | 14 | 18 | (4089000.) | 374 |

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P ( 1P* ) 3D 2D* 3

| | | | | |
|---|---|---|---|---|
| C | 2 | 6 | (248600.) | 374 |
| N | 3 | 7 | 396584.8 | 487 |
| O | 4 | 8 | 575853. | 487 |
| F | 5 | 9 | 787764. | 487 |
| NE | 6 | 10 | (1030000.) | 374 |
| NA | 7 | 11 | 1303643. | 487 |
| MG | 8 | 12 | 1608224. | 487 |
| AL | 9 | 13 | 1943980. | 487 |
| SI | 10 | 14 | 2311360. | 487 |
| P | 11 | 15 | 2709400. | 487 |
| S | 12 | 16 | (3139500.) | 374 |
| CL | 13 | 17 | (3602000.) | 374 |
| AR | 14 | 18 | (4096000.) | 374 |

1S2 2S 2P ( 3P* ) 3D 2F* 3

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (91700.) | 374 |
| C | 02 | 06 | 199941.84 | 287 |
| N | 3 | 7 | 339744.4 | 487 |
| O | 4 | 8 | 510744.9 | 086 |
| F | 5 | 9 | 712840. | 487 |
| NE | 6 | 10 | (945900.) | 374 |
| NA | 7 | 11 | 1209908. | 487 |
| MG | 8 | 12 | 1504992. | 487 |
| AL | 9 | 13 | 1831260. | 487 |
| SI | 10 | 14 | 2188570. | 487 |
| P | 11 | 15 | 2578000. | 487 |
| S | 12 | 16 | (2999000.) | 374 |
| CL | 13 | 17 | (3453000.) | 374 |
| AR | 14 | 18 | (3940000.) | 374 |

1S2 2S 2P ( 3P* ) 3D 2F* 4

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (91700.) | 374 |
| C | 02 | 06 | 199983.67 | 287 |
| N | 3 | 7 | 339855.7 | 487 |
| O | 4 | 8 | 510977.2 | 086 |
| F | 5 | 9 | 713306. | 487 |
| NE | 6 | 10 | (946700.) | 374 |
| NA | 7 | 11 | 1211236. | 487 |
| MG | 8 | 12 | 1507043. | 487 |
| AL | 9 | 13 | 1834300. | 487 |
| SI | 10 | 14 | 2193140. | 487 |
| P | 11 | 15 | 2584000. | 487 |
| S | 12 | 16 | (3007000.) | 374 |
| CL | 13 | 17 | (3463000.) | 374 |
| AR | 14 | 18 | (3953000.) | 374 |

TABLE VII BORON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P ( 1P* ) 3D 2F* 3

| | | | | |
|---|---|---|---|---|
| N | 3 | 7 | (395000.) | 374 |
| O | 4 | 8 | 570791. | 487 |
| F | 5 | 9 | 783650. | 487 |
| NE | 6 | 10 | (1022000.) | 374 |
| NA | 7 | 11 | 1292333. | 487 |
| MG | 8 | 12 | 1597469. | 487 |
| AL | 9 | 13 | 1933050. | 487 |
| SI | 10 | 14 | 2299860. | 487 |
| P | 11 | 15 | 2697820. | 487 |
| S | 12 | 16 | (3128000.) | 374 |

1S2 2S 2P ( 1P* ) 3D 2F* 4

| | | | | |
|---|---|---|---|---|
| N | 3 | 7 | (395000.) | 374 |
| O | 4 | 8 | 570791. | 487 |
| F | 5 | 9 | 783650. | 487 |
| NE | 6 | 10 | (1022000.) | 374 |
| NA | 7 | 11 | 1292333. | 487 |
| MG | 8 | 12 | 1597469. | 487 |
| AL | 9 | 13 | 1933050. | 487 |
| SI | 10 | 14 | 2299860. | 487 |
| P | 11 | 15 | 2697820. | 487 |
| S | 12 | 16 | (3128000.) | 374 |

1S2 2S 2P ( 3P* ) 4D 2F* 3

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (96000.) | 374 |
| C | 02 | 06 | 221461.31 | 287 |
| N | 3 | 7 | 387728.7 | 487 |
| O | 4 | 8 | 596295. | 086 |
| F | 5 | 9 | 847506. | 487 |
| NE | 6 | 10 | (1138500.) | 374 |
| NA | 7 | 11 | 1471559. | 487 |
| MG | 8 | 12 | 1846146. | 487 |
| AL | 9 | 13 | (2262400.) | 374 |
| SI | 10 | 14 | (2720000.) | 374 |

1S2 2S 2P ( 3P* ) 4D 2F* 4

| | | | | |
|---|---|---|---|---|
| B | 1 | 5 | (96000.) | 374 |
| C | 02 | 06 | 221503.76 | 287 |
| N | 3 | 7 | 387811.5 | 487 |
| O | 4 | 8 | 596475. | 086 |
| F | 5 | 9 | 847817. | 487 |
| NE | 6 | 10 | (1139100.) | 374 |
| NA | 7 | 11 | 1472727. | 487 |
| MG | 8 | 12 | 1848025. | 487 |
| AL | 9 | 13 | 2265580. | 487 |
| SI | 10 | 14 | (2724000.) | 374 |

TABLE VIII

TRANSITIONS - BORON ISOELECTRONIC SEQUENCE

| | | B I | C II | N III | O IV | F V | Ne VI | Na VII |
|---|---|---|---|---|---|---|---|---|
| $2s^2 2p - 2s^2 3s$ | $^2P^o_{3/2} - {}^2S_{1/2}$ | 2498.48 | 858.56 | 452.23 | 279.93 | 190.84 | 138.64 | 105.35 |
| $2s^2 2p - 2s^2 4s$ | $^2P^o_{3/2} - {}^2S_{1/2}$ | 1818.35 | 636.25 | 332.32 | 206.00 | 140.41 | (101.87) | 77.35 |
| $2s^2 2p - 2s2p^2$ | $^2P^o_{3/2} - {}^2S_{1/2}$ | 1573.67 | 1037.02 | 764.36 | 609.83 | 508.08 | 435.65 | 381.30 |
| $2s^2 3s - 2s^2 3p$ | $^2S_{1/2} - {}^2P^o_{3/2}$ | 11663.24 | 6579.87 | 4098.48 | 3064.35 | 2451.40 | 2043.04 | 1752.20 |
| $2s2p^2 - 1s^2 2p^3$ | $^2S_{1/2} - {}^2P^o_{3/2}$ | (2103.09) | 1383.99 | 1005.98 | 802.20 | 667.23 | 570.77 | 498.23 |
| | $^2P_{3/2} - {}^2D^o_{5/2}$ | (3669.32) | 2512.81 | 1751.75 | 1343.51 | 1088.40 | (913.34) | 778.05 |
| $2s2p(^3P^o)3s - (^3P^o)3p$ | $^2P^o_{3/2} - {}^2P_{3/2}$ | (83333.3) | 23530.1 | 8387.36 | 7005.99 | 5857.89 | (4830.92) | 4384.00 |
| | $^2P^o_{3/2} - {}^2D_{5/2}$ | (83333.3) | 9210.20 | 4201.20 | 3350.07 | 2698.55 | (2222.22) | 1939.49 |
| $2s2p(^1P^o)3s - (^1P^o)3p$ | $^2P^o_{3/2} - {}^2P_{3/2}$ | | (50000) | (5374.03) | 3208.73 | 2444.93 | (2100.84) | 1802.06 |
| | $^2P^o_{3/2} - {}^2D_{5/2}$ | | | (6956.04) | 3490.89 | 2584.18 | (2155.17) | 1861.26 |
| $2s2p(^3P^o)3p - (^3P^o)3d$ | $^2P_{3/2} - {}^2P^o_{3/2}$ | (12755.1) | 4966.12 | 2984.43 | 2133.54 | 1611.97 | (1321.00) | 1411.11 |
| | $^2P_{3/2} - {}^2D^o_{5/2}$ | (13698.7) | 6100.20 | 3939.63 | 2922.28 | 2328.13 | (1936.11) | 1654.15 |
| | $^2D_{5/2} - {}^2F^o_{7/2}$ | (17543.9) | 8770.40 | 5297.09 | 3532.20 | 2675.66 | 2141.33 | 1816.33 |
| $2s2p(^1P^o)3p - (^1P^o)3d$ | $^2P_{3/2} - {}^2D^o_{5/2}$ | | (8620.69) | 5269.59 | 3846.45 | 2931.86 | (2358.49) | 2005.45 |
| | $^2D_{5/2} - {}^2F^o_{7/2}$ | | | (4624.45) | 4263.48 | 3105.78 | (2808.99) | 2480.22 |
| $2s2p(^3P^o)3p - (^3P^o)4d$ | $^2D_{5/2} - {}^2F^o_{7/2}$ | (10000.0) | 3040.59 | 1498.22 | 880.64 | 583.45 | (419.64) | 317.08 |

Note: Transitions in Angstroms. ( ) indicates prediction.

TABLE VIII

TRANSITIONS - BORON ISOELECTRONIC SEQUENCE (continued)

| | | Mg VIII | Al IX | Si X | P XI | S XII | Cl XIII | Ar XIV |
|---|---|---|---|---|---|---|---|---|
| $2s^2 2p - 2s^2 3s$ | ${}^2P^o_{3/2} - {}^2S_{1/2}$ | 82.82 | 66.84 | (55.10) | 46.20 | (39.28) | (33.87) | (29.49) |
| $2s^2 2p - 2s^2 4s$ | ${}^2P^o_{3/2} - {}^2S_{1/2}$ | 60.81 | (49.07) | (40.42) | | | | |
| $2s^2 2p - 2s2p^2$ | ${}^2P^o_{3/2} - {}^2S_{1/2}$ | 339.01 | 300.62 | 277.27 | 254.05 | (233.99) | (216.64) | (201.26) |
| $2s^2 3s - 2s^2 3p$ | ${}^2S_{1/2} - {}^2O^o_{3/2}$ | (1531.14) | (1351.72) | | | | | |
| $2s2p^2 - 1s^2 2p^3$ | ${}^2S_{1/2} - {}^2P^o_{3/2}$ | 442.28 | 397.24 | 360.63 | (332.81) | (309.60) | (290.70) | |
| | ${}^2P_{3/2} - {}^2D^o_{5/2}$ | 690.34 | 614.97 | 554.45 | (508.52) | (462.96) | | |
| $2s2p({}^3P^o)3s - ({}^3P^o)3p$ | ${}^2P^o_{3/2} - {}^2P_{3/2}$ | 3895.60 | 3534.82 | 3247.81 | (3131.85) | | | |
| | ${}^2P^o_{3/2} - {}^2D_{5/2}$ | 1691.90 | 1495.66 | 1343.18 | (1251.09) | | | |
| $2s2p({}^1P^o)3s - ({}^1P^o)3p$ | ${}^2P^o_{3/2} - {}^2P_{3/2}$ | 1573.09 | 1401.15 | (1223.84) | | | | |
| | ${}^2P^o_{3/2} - {}^2D_{5/2}$ | 1616.66 | 1434.93 | (1303.61) | (1205.40) | | | |
| $2s2p({}^3P^o)3p - ({}^3P^o)3d$ | ${}^2P_{3/2} - {}^2P^o_{3/2}$ | 964.34 | 846.96 | 754.20 | (678.15) | (611.62) | | |
| | ${}^2P_{3/2} - {}^2D_{5/2}$ | 1442.90 | 1273.72 | 1138.43 | (1019.89) | (917.43) | | |
| | ${}^2D_{5/2} - {}^2F_{7/2}$ | 1557.46 | 1363.70 | 1206.56 | (1063.83) | | | |
| $2s2p({}^1P^o)3p - ({}^1P^o)3d$ | ${}^2P_{3/2} - {}^2D^o_{5/2}$ | 1734.30 | (1550.87) | (1401.35) | | | | |
| | ${}^2D_{5/2} - {}^2F^o_{7/2}$ | 2056.85 | 1774.94 | (1541.78) | (1354.65) | | | |
| $2s2p({}^3P^o)3p - ({}^3P^o)4d$ | ${}^2D_{5/2} - {}^2F^o_{7/2}$ | 246.80 | (198.06) | (162.94) | | | | |

TABLE IX CARBON ISOELECTRONIC SEQUENCE

1S2 2S2 2P2( ) G 3P 1

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 16.40 | 821 |
| N | 2 | 7 | 48.7 | 200 |
| O | 3 | 8 | 113.4 | 487 |
| F | 4 | 9 | 225.2 | 487 |
| NE | 5 | 10 | 414. | 487 |
| NA | 6 | 11 | 698. | 487 |
| MG | 7 | 12 | 1127. | 487 |
| AL | 8 | 13 | 1740. | 487 |
| SI | 9 | 14 | 2590. | 487 |
| P | 10 | 15 | 3390. | 487 |
| S | 11 | 16 | 5210. | 161 |
| CL | 12 | 17 | 7190. | 161 |
| AR | 13 | 18 | 9870. | 161 |
| K | 14 | 19 | *13220.* | 161T |
| CA | 15 | 20 | 17556. | 487 |
| SC | 16 | 21 | (22900.) | 374 |
| TI | 17 | 22 | (29500.) | 374 |
| V | 18 | 23 | (37500.) | 374 |

1S2 2S2 2P2( ) G 3P 2

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 43.40 | 821 |
| N | 2 | 7 | 130.8 | 200 |
| O | 3 | 8 | 306.8 | 487 |
| F | 4 | 9 | 613.4 | 487 |
| NE | 5 | 10 | 1112. | 487 |
| NA | 6 | 11 | 1858. | 487 |
| MG | 7 | 12 | 2939. | 487 |
| AL | 8 | 13 | 4440. | 487 |
| SI | 9 | 14 | 6460. | 487 |
| P | 10 | 15 | 8580. | 487 |
| S | 11 | 16 | 12400. | 161 |
| CL | 12 | 17 | 16570. | 161 |
| AR | 13 | 18 | 21850. | 161 |
| K | 14 | 19 | *28060.* | 161T |
| CA | 15 | 20 | 35911. | 487 |
| SC | 16 | 21 | (45200.) | 374 |
| TI | 17 | 22 | (56100.) | 374 |
| V | 18 | 23 | (68900.) | 374 |

1S2 2S2 2P2( ) 1S 0

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 21648.01 | 821 |
| N | 2 | 7 | 32688.8 | 200 |
| O | 3 | 8 | 43183.5 | 487 |
| F | 4 | 9 | 53544. | 487 |
| NE | 5 | 10 | 63900. | 487 |
| NA | 6 | 11 | *74394.* | 487 |
| MG | 7 | 12 | *85109.* | 487 |
| AL | 8 | 13 | *96170.* | 487 |
| SI | 9 | 14 | *107780.* | 487 |
| P | 10 | 15 | 119430. | 487 |
| S | 11 | 16 | (131000.) | 374 |
| CL | 12 | 17 | *158990.* | 161 |
| AR | 13 | 18 | *175720.* | 161 |
| K | 14 | 19 | *186370.* | 161T |
| CA | 15 | 20 | *207340.* | 161T |

TABLE IX CARBON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P3( ) 3D* 1

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 64089.85 | 821 |
| N | 2 | 7 | 92251.8 | 200 |
| O | 3 | 8 | 120058.5 | 487 |
| F | 4 | 9 | 147901.6 | 487 |
| NE | 5 | 10 | 175927. | 487 |
| NA | 6 | 11 | 204260. | 487 |
| MG | 7 | 12 | 233027. | 487 |
| AL | 8 | 13 | 262390. | 487 |
| SI | 9 | 14 | 292440. | 487 |
| P | 10 | 15 | 323160. | 487 |
| S | 11 | 16 | (349000.) | 374 |
| CL | 12 | 17 | (378000.) | 374 |
| AR | 13 | 18 | (406000.) | 374 |

1S2 2S 2P3( ) 3D* 2

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 64090.95 | 821 |
| N | 2 | 7 | 92250.3 | 200 |
| O | 3 | 8 | 120052.6 | 487 |
| F | 4 | 9 | 147888.9 | 487 |
| NE | 5 | 10 | 175905. | 487 |
| NA | 6 | 11 | 204222. | 487 |
| MG | 7 | 12 | 232975. | 487 |
| AL | 8 | 13 | 262320. | 487 |
| SI | 9 | 14 | 292360. | 487 |
| P | 10 | 15 | 323010. | 487 |
| S | 11 | 16 | (349000.) | 374 |
| CL | 12 | 17 | (378000.) | 374 |
| AR | 13 | 18 | (406000.) | 374 |

1S2 2S 2P3( ) 3D* 3

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 64086.92 | 821 |
| N | 2 | 7 | 92237.2 | 200 |
| O | 3 | 8 | 120025.4 | 487 |
| F | 4 | 9 | 147841.8 | 487 |
| NE | 5 | 10 | 175834. | 487 |
| NA | 6 | 11 | 204131. | 487 |
| MG | 7 | 12 | 232865. | 487 |
| AL | 8 | 13 | 262190. | 487 |
| SI | 9 | 14 | 292210. | 487 |
| P | 10 | 15 | 322790. | 487 |
| S | 11 | 16 | (349000.) | 374 |
| CL | 12 | 17 | (378000.) | 374 |
| AR | 13 | 18 | (406000.) | 374 |

TABLE IX CARBON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P ( 2P* ) 3S 3P* 0

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 60333.43 | 821 |
| N | 2 | 7 | 148908.59 | 200 |
| O | 3 | 8 | 267257.29 | 487 |
| F | 4 | 9 | 416417.3 | 487 |
| NE | 5 | 10 | 596258. | KA60 |
| NA | 6 | 11 | (806700.) | 374 |
| MG | 7 | 12 | 1047624. | 487 |
| AL | 8 | 13 | 1319280. | 487 |
| SI | 9 | 14 | (1621000.) | 374 |
| P | 10 | 15 | 1954140. | 487 |
| S | 11 | 16 | (2317000.) | 374 |
| CL | 12 | 17 | (2711000.) | 374 |
| AR | 13 | 18 | (3136000.) | 374 |

1S2 2S2 2P ( 2P* ) 3S 3P* 1

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 60352.63 | 821 |
| N | 2 | 7 | 148940.17 | 200 |
| O | 3 | 8 | 267375.65 | 487 |
| F | 4 | 9 | 416639.8 | 487 |
| NE | 5 | 10 | 596626. | 487 |
| NA | 6 | 11 | 807324. | 487 |
| MG | 7 | 12 | 1048385. | 487 |
| AL | 8 | 13 | 1320450. | 487 |
| SI | 9 | 14 | 1623380. | 487 |
| P | 10 | 15 | 1955980. | 487 |
| S | 11 | 16 | (2320000.) | 374 |
| CL | 12 | 17 | (2714000.) | 374 |
| AR | 13 | 18 | (3139000.) | 374 |

1S2 2S2 2P ( 2P* ) 3S 3P* 2

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 60393.14 | 821 |
| N | 2 | 7 | 149076.52 | 200 |
| O | 3 | 8 | 267632.59 | 487 |
| F | 4 | 9 | 417143.4 | 487 |
| NE | 5 | 10 | 597528. | KA60 |
| NA | 6 | 11 | 808795. | 487 |
| MG | 7 | 12 | 1050906. | 487 |
| AL | 8 | 13 | 1324080. | 487 |
| SI | 9 | 14 | 1628550. | 487 |
| P | 10 | 15 | 1963430. | 487 |
| S | 11 | 16 | (2329000.) | 374 |
| CL | 12 | 17 | (2726000.) | 374 |
| AR | 13 | 18 | (3153000.) | 374 |

TABLE IX CARBON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P ( 2P* ) 3S 1P* 1

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 61981.82 | 821 |
| N | 2 | 7 | 149187.80 | 200 |
| O | 3 | 8 | 273080.07 | 487 |
| F | 4 | 9 | 423606.4 | 487 |
| NE | 5 | 10 | 605231. | 487 |
| NA | 6 | 11 | 817718. | 487 |
| MG | 7 | 12 | *1060996.* | 487 |
| AL | 8 | 13 | *1335270.* | 487 |
| SI | 9 | 14 | *1640920.* | 487 |
| P | 10 | 15 | 1976578. | 487 |
| S | 11 | 16 | (2343000.) | 374 |
| CL | 12 | 17 | (2740000.) | 374 |
| AR | 13 | 18 | (3168000.) | 374 |

1S2 2S2 2P ( 2P* ) 3P 3S 1

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 70743.95 | 821 |
| N | 2 | 7 | 168892.21 | 200 |
| O | 3 | 8 | 297557.50 | 487 |
| F | 4 | 9 | 456884.3 | 487 |
| NE | 5 | 10 | (646900.) | 374 |
| NA | 6 | 11 | (867800.) | 374 |
| MG | 7 | 12 | (1119000.) | 374 |
| AL | 8 | 13 | 1402180. | 487 |
| SI | 9 | 14 | (1716000.) | 374 |

1S2 2S2 2P ( 2P* ) 3P 1S 0

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 73975.91 | 821 |
| N | 2 | 7 | 178273.38 | 200 |
| O | 3 | 8 | 313801.07 | 487 |
| F | 4 | 9 | (480600.) | 374 |
| NE | 5 | 10 | (678500.) | 374 |

1S2 2S2 2P ( 2P* ) 3P 3P 0

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 71352.51 | 821 |
| N | 2 | 7 | 170572.61 | 200 |
| O | 3 | 8 | 300228.21 | 487 |
| F | 4 | 9 | 460215.2 | 487 |
| NE | 5 | 10 | (650700.) | 374 |
| NA | 6 | 11 | (871800.) | 374 |
| MG | 7 | 12 | 1123745. | 487 |
| AL | 8 | 13 | (1407000.) | 374 |
| SI | 9 | 14 | (1720000.) | 374 |

1S2 2S2 2P ( 2P* ) 3P 3P 1

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 71364.90 | 821 |
| N | 2 | 7 | 170607.89 | 200 |
| O | 3 | 8 | 300310.31 | 487 |
| F | 4 | 9 | 460385.8 | 487 |
| NE | 5 | 10 | (651100.) | 374 |
| NA | 6 | 11 | 872577. | 487 |
| MG | 7 | 12 | 1124937. | 487 |
| AL | 8 | 13 | (1408000.) | 374 |
| SI | 9 | 14 | (1721000.) | 374 |

TABLE IX CARBON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P ( 2P* ) 3P 3P 2

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 71385.38 | 821 |
| N | 2 | 7 | 170666.23 | 200 |
| O | 3 | 8 | 300440.85 | 487 |
| F | 4 | 9 | 460640.6 | 487 |
| NE | 5 | 10 | (651600.) | 374 |
| NA | 6 | 11 | 873287. | 487 |
| MG | 7 | 12 | 1125850. | 487 |
| AL | 8 | 13 | (1409000.) | 374 |
| SI | 9 | 14 | (1722000.) | 374 |

1S2 2S2 2P ( 2P* ) 3P 1P 1

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 68856.33 | 821 |
| N | 2 | 7 | 164610.76 | 200 |
| O | 3 | 8 | 290956.62 | 487 |
| F | 4 | 9 | (447900.) | 374 |
| NE | 5 | 10 | (635400.) | 374 |

1S2 2S2 2P ( 2P* ) 3P 3D 1

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 69689.48 | 821 |
| N | 2 | 7 | 166521.69 | 200 |
| O | 3 | 8 | 293865.26 | 487 |
| F | 4 | 9 | 451819.6 | 487 |
| NE | 5 | 10 | 640422. | KA60 |
| NA | 6 | 11 | (859600.) | 374 |
| MG | 7 | 12 | (1109000.) | 374 |

1S2 2S2 2P ( 2P* ) 3P 3D 2

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 69710.66 | 821 |
| N | 2 | 7 | 166582.45 | 200 |
| O | 3 | 8 | 294001.60 | 487 |
| F | 4 | 9 | 452081.1 | 487 |
| NE | 5 | 10 | 640868. | KA60 |
| NA | 6 | 11 | (860200.) | 374 |
| MG | 7 | 12 | (1110000.) | 374 |

1S2 2S2 2P ( 2P* ) 3P 3D 3

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 69744.03 | 821 |
| N | 2 | 7 | 166678.64 | 200 |
| O | 3 | 8 | 294221.65 | 487 |
| F | 4 | 9 | 452517.1 | 487 |
| NE | 5 | 10 | 641651. | KA60 |
| NA | 6 | 11 | (861400.) | 374 |
| MG | 7 | 12 | (1112000.) | 374 |

1S2 2S2 2P ( 2P* ) 3P 1D 2

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 72610.72 | 821 |
| N | 2 | 7 | 174212.03 | 200 |
| O | 3 | 8 | 306584.8 | 487 |
| F | 4 | 9 | 469644.2 | 487 |
| NE | 5 | 10 | (663500.) | 374 |
| NA | 6 | 11 | (888000.) | 374 |

TABLE IX CARBON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P ( 2P* ) 3D 3P* 0

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 79323.16 | 821 |
| N | 2 | 7 | 188937.24 | 200 |
| O | 3 | 8 | 329643.43 | 487 |
| F | 4 | 9 | 500716.5 | 487 |
| NE | 5 | 10 | 702459. | 487 |
| NA | 6 | 11 | 934745. | 487 |
| MG | 7 | 12 | 1197872. | 487 |
| AL | 8 | 13 | 1492140. | 487 |
| SI | 9 | 14 | 1817670. | 487 |
| P | 10 | 15 | 2173990. | 487 |
| S | 11 | 16 | (2562000.) | 374 |
| CL | 12 | 17 | (2982000.) | 374 |
| AR | 13 | 18 | (3434000.) | 374 |

1S2 2S2 2P ( 2P* ) 3D 3P* 1

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 79318.78 | 821 |
| N | 2 | 7 | 188909.17 | 200 |
| O | 3 | 8 | 329581.98 | 487 |
| F | 4 | 9 | 500602.1 | 487 |
| NE | 5 | 10 | 702074. | 487 |
| NA | 6 | 11 | 934463. | 487 |
| MG | 7 | 12 | 1197469. | 487 |
| AL | 8 | 13 | 1491570. | 487 |
| SI | 9 | 14 | 1816940. | 487 |
| P | 10 | 15 | 2173040. | 487 |
| S | 11 | 16 | (2561000.) | 374 |
| CL | 12 | 17 | (2981000.) | 374 |
| AR | 13 | 18 | (3432000.) | 374 |

1S2 2S2 2P ( 2P* ) 3D 3P* 2

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 79310.85 | 821 |
| N | 2 | 7 | 188857.37 | 200 |
| O | 3 | 8 | 329467.98 | 487 |
| F | 4 | 9 | 500390.1 | 487 |
| NE | 5 | 10 | 701765. | 487 |
| NA | 6 | 11 | 933915. | 487 |
| MG | 7 | 12 | 1196770. | 487 |
| AL | 8 | 13 | 1490590. | 487 |
| SI | 9 | 14 | 1815690. | 487 |
| P | 10 | 15 | 2171630. | 487 |
| S | 11 | 16 | (2559000.) | 374 |
| CL | 12 | 17 | (2979000.) | 374 |
| AR | 13 | 18 | (3429000.) | 374 |

TABLE IX CARBON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P ( 2P* ) 3D 1P* 1

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 78731.27 | 821 |
| N | 2 | 7 | 190120.24 | 200 |
| O | 3 | 8 | 332777.1 | 487 |
| F | 4 | 9 | 506514. | 487 |
| NE | 5 | 10 | 702412. | 487 |
| NA | 6 | 11 | *946512.* | 487 |
| MG | 7 | 12 | *1212759.* | 487 |
| AL | 8 | 13 | *1510060.* | 487 |
| SI | 9 | 14 | 1838540. | 487 |
| P | 10 | 15 | 2197500. | 487 |
| S | 11 | 16 | (2589000.) | 374 |
| CL | 12 | 17 | (3013000.) | 374 |
| AR | 13 | 18 | (3468000.) | 374 |

1S2 2S2 2P ( 2P* ) 3D 3D* 1

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 78293.49 | 821 |
| N | 2 | 7 | 187437.56 | 200 |
| O | 3 | 8 | 327227.94 | 487 |
| F | 4 | 9 | 497481.4 | 487 |
| NE | 5 | 10 | 698231. | 487 |
| NA | 6 | 11 | 929774. | 487 |
| MG | 7 | 12 | 1191753. | 487 |
| AL | 8 | 13 | 1484560. | 487 |
| SI | 9 | 14 | 1808160. | 487 |
| P | 10 | 15 | 2162410. | 487 |
| S | 11 | 16 | (2547000.) | 374 |
| CL | 12 | 17 | (2962000.) | 374 |
| AR | 13 | 18 | (3408000.) | 374 |
| K | 14 | 19 | (3885000.) | 374 |

1S2 2S2 2P ( 2P* ) 3D 3D* 2

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 78307.63 | 821 |
| N | 2 | 7 | 187461.56 | 200 |
| O | 3 | 8 | 327277.18 | 487 |
| F | 4 | 9 | 497575.6 | 487 |
| NE | 5 | 10 | 698382. | 487 |
| NA | 6 | 11 | 929999. | 487 |
| MG | 7 | 12 | 1192185. | 487 |
| AL | 8 | 13 | 1485240. | 487 |
| SI | 9 | 14 | 1809080. | 487 |
| P | 10 | 15 | 2163500. | 487 |
| S | 11 | 16 | (2548000.) | 374 |
| CL | 12 | 17 | (2964000.) | 374 |
| AR | 13 | 18 | (3410000.) | 374 |
| K | 14 | 19 | (3888000.) | 374 |

1S2 2S2 2P ( 2P* ) 3D 3D* 3

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 78318.25 | 821 |
| N | 2 | 7 | 187491.90 | 200 |
| O | 3 | 8 | 327350.90 | 487 |
| F | 4 | 9 | 497729.1 | 487 |
| NE | 5 | 10 | 698735. | 487 |
| NA | 6 | 11 | 930510. | 487 |
| MG | 7 | 12 | 1193061. | 487 |
| AL | 8 | 13 | 1486710. | 487 |
| SI | 9 | 14 | 1811480. | 487 |
| P | 10 | 15 | 2166800. | 487 |
| S | 11 | 16 | (2552000.) | 374 |
| CL | 12 | 17 | (2969000.) | 374 |
| AR | 13 | 18 | (3417000.) | 374 |
| K | 14 | 19 | (3895000.) | 374 |

1S2 2S2 2P ( 2P* ) 3D 1D* 2

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 77679.82 | 821 |
| N | 2 | 7 | 187091.37 | 200 |
| O | 3 | 8 | 324734.22 | 487 |
| F | 4 | 9 | 492864. | 487 |
| NE | 5 | 10 | 690691. | 487 |
| NA | 6 | 11 | *920826. * | 487 |
| MG | 7 | 12 | *1180886.* | 487 |
| AL | 8 | 13 | *1471980.* | 487 |
| SI | 9 | 14 | 1794090. | 487 |
| P | 10 | 15 | 2147190. | 487 |
| S | 11 | 16 | (2531000.) | 374 |
| CL | 12 | 17 | 2955760. | 269 |
| AR | 13 | 18 | (3388000.) | 374 |
| K | 14 | 19 | (3862000.) | 374 |

1S2 2S2 2P ( 2P* ) 3D 3F* 2

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 78199.07 | 821 |
| N | 2 | 7 | 186511.58 | 200 |
| O | 3 | 8 | 324462.46 | 487 |
| F | 4 | 9 | 492395.1 | 487 |
| NE | 5 | 10 | (690000.) | 374 |
| NA | 6 | 11 | 919476. | 487 |
| MG | 7 | 12 | *1178758.* | 487 |
| AL | 8 | 13 | *1468700.* | 487 |
| SI | 9 | 14 | *1789000.* | 487 |
| P | 10 | 15 | 2140410. | 487 |
| S | 11 | 16 | (2521000.) | 374 |

TABLE IX CARBON ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P ( 2P* ) 3D 3F* 3

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 78215.51 | 821 |
| N | 2 | 7 | 186570.98 | 200 |
| O | 3 | 8 | 324658.25 | 487 |
| F | 4 | 9 | 492858.8 | 487 |
| NE | 5 | 10 | (690900.) | 374 |
| NA | 6 | 11 | 919476. | 487 |
| MG | 7 | 12 | *1178758.* | 487 |
| AL | 8 | 13 | *1468700.* | 487 |
| SI | 9 | 14 | *1789000.* | 487 |
| P | 10 | 15 | 2140400. | 487 |
| S | 11 | 16 | (2521000.) | 374 |

1S2 2S2 2P ( 2P* ) 3D 3F* 4

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 78249.94 | 821 |
| N | 2 | 7 | 186652.49 | 200 |
| O | 3 | 8 | 324836.41 | 487 |
| F | 4 | 9 | 493206.2 | 487 |
| NE | 5 | 10 | (691500.) | 374 |
| NA | 6 | 11 | 919476. | 487 |
| MG | 7 | 12 | *1178758.* | 487 |
| AL | 8 | 13 | *1468700.* | 487 |
| SI | 9 | 14 | *1789000.* | 487 |
| P | 10 | 15 | 2140400. | 487 |
| S | 11 | 16 | (2521000.) | 374 |

1S2 2S2 2P ( 2P* ) 3D 1F* 3

| | | | | |
|---|---|---|---|---|
| C | 1 | 6 | 78529.62 | 821 |
| N | 2 | 7 | 189335.16 | 200 |
| O | 3 | 8 | 331820.2 | 487 |
| F | 4 | 9 | 505421.4 | 487 |
| NE | 5 | 10 | 709956. | 487 |
| NA | 6 | 11 | *945429.* | 487 |
| MG | 7 | 12 | *1211785.* | 487 |
| AL | 8 | 13 | *1509210.* | 487 |
| SI | 9 | 14 | 1837810. | 487 |
| P | 10 | 15 | 2197500. | 487 |
| S | 11 | 16 | (2588000.) | 374 |
| CL | 12 | 17 | (3010000.) | 374 |
| AR | 13 | 18 | (3463000.) | 374 |
| K | 14 | 19 | (3946000.) | 374 |

TABLE X

TRANSITIONS - CARBON ISOELECTRONIC SEQUENCE

| | | C I | N II | O III | F IV | Ne V | Na VI | Mg VII |
|---|---|---|---|---|---|---|---|---|
| $2p^2 - 2s2p^3$ | $^3P_2 - ^3D_3^0$ | 1561.44 | 1085.70 | 835.29 | 679.22 | 572.34 | 494.38 | 434.92 |
| $2p^2 - 2p(^2P^0)3s$ | $^3P_2 - ^3P_2^0$ | 1657.01 | 671.39 | 374.08 | 240.08 | 167.67 | 123.93 | 95.42 |
| | $^1S_0 - ^1P_1^0$ | 2479.31 | 858.38 | 434.98 | 270.22 | 184.73 | 134.53 | 102.47 |
| $2p^2 - 2p(^2P^0)3d$ | $^3P_2 - ^3P_2^0$ | 1261.55 | 529.87 | 303.80 | 200.09 | 142.72 | 107.29 | 83.76 |
| | $^3P_2 - ^3D_3^0$ | 1277.55 | 533.73 | 305.77 | 201.16 | 143.34 | 107.68 | 84.02 |
| | $^1S_0 - ^1P_1^0$ | 1751.83 | 635.20 | 345.31 | 220.77 | 156.61 | 114.66 | 88.68 |
| | $^1D_2 - ^1D_2^0$ | 1481.76 | 582.16 | 328.45 | 213.85 | 151.42 | 112.95 | 87.72 |
| | $^1D_2 - ^1F_3^0$ | 1463.34 | 574.65 | 320.98 | 208.26 | 147.13 | 109.90 | 85.40 |
| $2p(^2P^0)3s - 2p(^2P^0)3p$ | $^3P_2^0 - ^3S_1$ | 9661.08 | 5046.51 | 3341.70 | 2516.30 | (2025.44) | (1694.77) | (1468.56) |
| | $^3P_2^0 - ^3P_2$ | 9097.33 | 4631.84 | 3048.01 | 2299.00 | (1849.39) | 1550.58 | 1334.33 |
| | $^3P_2^0 - ^3D_3$ | 10694.17 | 5681.13 | 3760.95 | 2826.97 | 2307.34 | (1900.96) | (1636.82) |
| | $^1P_1^0 - ^1S_0$ | 8349.97 | 3438.13 | 2455.74 | (1754.58) | (1364.83) | | |
| | $^1P_1^0 - ^1P_1$ | 14546.49 | 6483.84 | 5593.92 | (4116.31) | (3314.66) | | |
| | $^1P_1^0 - ^1D_2$ | 9408.31 | 3961.60 | 2984.65 | 2172.13 | (1716.18) | (1422.84) | |
| $2p(^2P^0)3p - 2p(^2P^0)3d$ | $^3D_3 - ^3F_4^0$ | 11756.53 | 5006.55 | 3266.40 | 2457.66 | (2006.06) | (1721.88) | (1497.95) |

Note: Transitions in Angstroms. (        ) indicates predictions.

TABLE X

TRANSITIONS - CARBON ISOELECTRONIC SEQUENCE (continued)

| | | Al VIII | Si IX | P X | S XI | Cl XII | Ar XIII | K XIV |
|---|---|---|---|---|---|---|---|---|
| $2p^2 - 2s2p^3$ | $^3P_2 - {}^3D^0_3$ | 387.97 | 349.96 | 318.26 | (297.09) | (276.68) | (260.32) | |
| $2p^2 - 2p(^2P^0)3s$ | $^3P_2 - {}^3P^0_2$ | 75.78 | 61.65 | 51.15 | (43.17) | (36.91) | (31.94) | |
| | $^1S_0 - {}^1P^0_1$ | 80.70 | 65.23 | 53.85 | (45.21) | (38.74) | (33.42) | |
| $2p^2 - 2p(^2P^0)3d$ | $^3P_2 - {}^3P^0_2$ | 67.29 | 55.27 | 46.23 | (39.27) | (33.76) | (29.35) | |
| | $^3P_2 - {}^3D^0_3$ | 67.46 | 55.40 | 46.33 | (39.38) | (33.87) | (29.45) | (25.86) |
| | $^1S_0 - {}^1P^0_1$ | 70.73 | 57.78 | 48.12 | (40.68) | (35.04) | (30.37) | |
| | $^1D_2 - {}^1D^0_2$ | 70.16 | 57.43 | 47.90 | (40.53) | (34.96) | (30.36) | (26.56) |
| | $^1D_2 - {}^1F^0_3$ | 68.38 | 56.03 | 46.77 | (39.62) | (34.18) | (29.68) | (25.98) |
| $2p(^2P^0)3s - 2p(^2P^0)3p$ | $^3P^0_2 - {}^3S_1$ | 1280.41 | (1143.51) | | | | | |
| | $^3P^0_2 - {}^3P_2$ | (1177.58) | (1070.09) | | | | | |
| | $^3P^0_2 - {}^3D_3$ | | | | | | | |
| | $^1P^0_1 - {}^1S_0$ | | | | | | | |
| | $^1P^0_1 - {}^1P_1$ | | | | | | | |
| | $^1P^0_1 - {}^1D_2$ | | | | | | | |
| $2p(^2P^0)3p - 2p(^2P^0)3d$ | $^3D_3 - {}^3F^0_4$ | | | | | | | |

TABLE XI NITROGEN ISOELECTRONIC SEQUENCE

| 1S2 2S2 2P3( ) | | | | 2P* 1 |
|---|---|---|---|---|
| N | 1 | 7 | 28838.920 | 376 |
| O | 2 | 8 | 40468.4 | 487 |
| F | 3 | 9 | 51558. | 487 |
| NE | 4 | 10 | *62150.* | 487 |
| NA | 5 | 11 | *73221.* | 487 |
| MG | 6 | 12 | *83805.* | 487 |
| AL | 7 | 13 | *94380.* | 487 |
| SI | 8 | 14 | *103320.* | 487 |
| P | 9 | 15 | *113457.* | 487 |
| S | 10 | 16 | *122230.* | 161 |
| CL | 11 | 17 | *139950.* | 161 |
| AR | 12 | 18 | *147610.* | 161 |
| K | 13 | 19 | *159570.* | 161T |
| CA | 14 | 20 | *171800.* | 161T |
| SC | 15 | 21 | (179000.) | 374 |
| TI | 16 | 22 | (190000.) | 374 |
| V | 17 | 23 | (201000.) | 374 |
| CR | 18 | 24 | (211000.) | 374 |

| 1S2 2S2 2P3( ) | | | | 2P* 2 |
|---|---|---|---|---|
| N | 1 | 7 | 28839.306 | 376 |
| O | 2 | 8 | 40466.9 | 487 |
| F | 3 | 9 | 51558. | 487 |
| NE | 4 | 10 | *62157.* | 487 |
| NA | 5 | 11 | *73260.* | 487 |
| MG | 6 | 12 | *83927.* | 487 |
| AL | 7 | 13 | *94650.* | 487 |
| SI | 8 | 14 | *103900.* | 487 |
| P | 9 | 15 | *114430.* | 487 |
| S | 10 | 16 | *124080.* | 161 |
| CL | 11 | 17 | *143000.* | 161 |
| AR | 12 | 18 | *152580.* | 161 |
| K | 13 | 19 | *166830.* | 161T |
| CA | 14 | 20 | *182000.* | 161T |
| SC | 15 | 21 | (191000.) | 374 |
| TI | 16 | 22 | (204000.) | 374 |
| V | 17 | 23 | (218000.) | 374 |
| CR | 18 | 24 | (231000.) | 374 |

| 1S2 2S2 2P3( ) | | | | 2D* 2 |
|---|---|---|---|---|
| N | 1 | 7 | 19233.177 | 205 |
| O | 2 | 8 | 26829.4 | 487 |
| F | 3 | 9 | 34120. | 487 |
| NE | 4 | 10 | *40995.* | 487 |
| NA | 5 | 11 | *48362.* | 487 |
| MG | 6 | 12 | *55266.* | 487 |
| AL | 7 | 13 | *62080.* | 487 |
| SI | 8 | 14 | *67140.* | 487 |
| P | 9 | 15 | *73167.* | 487 |
| S | 10 | 16 | *77670.* | 161 |
| CL | 11 | 17 | *90760.* | 161 |
| AR | 12 | 18 | *93400.* | 161 |
| K | 13 | 19 | *100000.* | 161 |
| CA | 14 | 20 | *172320.* | 269 |
| CA | 14 | 20 | *106600.* | 161T |
| SC | 15 | 21 | (114000.) | 374 |
| TI | 16 | 22 | (121000.) | 374 |
| V | 17 | 23 | (127000.) | 374 |
| CR | 18 | 24 | (134000.) | 374 |

TABLE XI NITROGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3( ) 2D* 3

| | | | | |
|---|---|---|---|---|
| N | 1 | 7 | 19224.464 | 205 |
| O | 2 | 8 | 26808.4 | 487 |
| F | 3 | 9 | 34084. | 487 |
| NE | 4 | 10 | *40950.* | 487 |
| NA | 5 | 11 | *48337.* | 487 |
| MG | 6 | 12 | *55245.* | 487 |
| AL | 7 | 13 | *62140.* | 487 |
| SI | 8 | 14 | *67420.* | 487 |
| P | 9 | 15 | *73730.* | 487 |
| S | 10 | 16 | *78800.* | 161 |
| CL | 11 | 17 | *92800.* | 161 |
| AR | 12 | 18 | *96750.* | 161 |
| K | 13 | 19 | *105430.* | 161 |
| CA | 14 | 20 | *180000.* | 269 |
| CA | 14 | 20 | *114780.* | 161T |
| SC | 15 | 21 | (124000.) | 374 |
| TI | 16 | 22 | (133000.) | 374 |
| V | 17 | 23 | (142000.) | 374 |
| CR | 18 | 24 | (152000.) | 374 |

1S2 2S 2P4( ) 2S 1

| | | | | |
|---|---|---|---|---|
| N | 1 | 7 | (144000.) | 374 |
| O | 2 | 8 | 195710.4 | 487 |
| F | 3 | 9 | 248260. | 487 |
| NE | 4 | 10 | *299351.* | 487 |
| NA | 5 | 11 | *350754.* | 487 |
| MG | 6 | 12 | *401714.* | 487 |
| AL | 7 | 13 | *452740.* | 487 |
| SI | 8 | 14 | *502360.* | 487 |
| P | 9 | 15 | *552540.* | 487 |
| S | 10 | 16 | *604080.* | 161 |
| CL | 11 | 17 | *663670.* | 161 |
| AR | 12 | 18 | *713900.* | 161 |
| K | 13 | 19 | *769380.* | 161T |
| CA | 14 | 20 | *825430.* | 161T |
| SC | 15 | 21 | (866000.) | 374 |
| TI | 16 | 22 | (917000.) | 374 |
| V | 17 | 23 | (969000.) | 374 |
| CR | 18 | 24 | (1020000.) | 374 |

1S2 2S 2P4( ) 4P 1

| | | | | |
|---|---|---|---|---|
| N | 1 | 7 | 88170.54 | EJ61 |
| O | 2 | 8 | 120083.5 | 487 |
| F | 3 | 9 | 152410.0 | 487 |
| NE | 4 | 10 | 184799. | 487 |
| NA | 5 | 11 | 217440. | 487 |
| MG | 6 | 12 | 250445. | 487 |
| AL | 7 | 13 | 283960. | 487 |
| SI | 8 | 14 | 318160. | 487 |
| P | 9 | 15 | 353050. | 487 |
| S | 10 | 16 | 388870. | 161 |
| CL | 11 | 17 | 425830. | 161 |
| AR | 12 | 18 | 464050. | 161 |
| K | 13 | 19 | 503730. | 269 |
| CA | 14 | 20 | 545080. | 269 |
| SC | 15 | 21 | (588400.) | 374 |
| TI | 16 | 22 | (633800.) | 374 |
| V | 17 | 23 | (681700.) | 374 |
| CR | 18 | 24 | (732300.) | 374 |

TABLE XI NITROGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P4( ) 4P 2

| | | | | |
|---|---|---|---|---|
| N | 1 | 7 | 88151.14 | EJ61 |
| O | 2 | 8 | 120001.1 | 487 |
| F | 3 | 9 | 152235.3 | 487 |
| NE | 4 | 10 | 184477. | 487 |
| NA | 5 | 11 | 216896. | 487 |
| MG | 6 | 12 | 249578. | 487 |
| AL | 7 | 13 | 282660. | 487 |
| SI | 8 | 14 | 316260. | 487 |
| P | 9 | 15 | 350440. | 487 |
| S | 10 | 16 | 385320. | 161 |
| CL | 11 | 17 | 421190. | 161 |
| AR | 12 | 18 | 458110. | 161 |
| K | 13 | 19 | 496350. | 269 |
| CA | 14 | 20 | 535850. | 269 |
| SC | 15 | 21 | (577200.) | 374 |
| TI | 16 | 22 | (620300.) | 374 |
| V | 17 | 23 | (665600.) | 374 |
| CR | 18 | 24 | (713300.) | 374 |

1S2 2S 2P4( ) 4P 3

| | | | | |
|---|---|---|---|---|
| N | 1 | 7 | 88107.23 | EJ61 |
| O | 2 | 8 | 119837.7 | 487 |
| F | 3 | 9 | 151897.9 | 487 |
| NE | 4 | 10 | 183860. | 487 |
| NA | 5 | 11 | 215860. | 487 |
| MG | 6 | 12 | 247945. | 487 |
| AL | 7 | 13 | 280200. | 487 |
| SI | 8 | 14 | 312670. | 487 |
| P | 9 | 15 | 345390. | 487 |
| S | 10 | 16 | 378450. | 161 |
| CL | 11 | 17 | 411930. | 161 |
| AR | 12 | 18 | 445940. | 161 |
| K | 13 | 19 | 480520. | 269 |
| CA | 14 | 20 | 515780. | 269 |
| SC | 15 | 21 | (551900.) | 374 |
| TI | 16 | 22 | (589000.) | 374 |
| V | 17 | 23 | (627100.) | 374 |
| CR | 18 | 24 | (666500.) | 374 |

TABLE XII

TRANSITIONS - NITROGEN ISOELECTRONIC SEQUENCE

| | | N I | O II | F III | Ne IV | Na V | Mg VI | Al VII | Si VIII | P IX |
|---|---|---|---|---|---|---|---|---|---|---|
| $2s^2 2p - 2s2p^4$ | $^4S^0_{3/2} - {}^4P_{1/2}$ | 1134.17 | 832.75 | 656.12 | 541.13 | 459.90 | 399.29 | 352.16 | 314.31 | 283.25 |
| | $^4S^0_{3/2} - {}^4P_{3/2}$ | 1134.42 | 833.33 | 656.88 | 542.07 | 461.05 | 400.68 | 353.78 | 316.20 | 285.36 |
| | $^4S^0_{3/2} - {}^4P_{5/2}$ | 1134.98 | 834.46 | 658.34 | 543.89 | 463.26 | 403.32 | 356.89 | 319.83 | 289.53 |
| | $^2P^0_{1/2} - {}^2S_{1/2}$ | (868.35) | 644.16 | 508.38 | 421.58 | 360.32 | 314.55 | 279.05 | 250.60 | 227.75 |
| | $^2P^0_{3/2} - {}^2S_{1/2}$ | (868.35) | 644.15 | 508.38 | 421.59 | 360.37 | 314.67 | 279.26 | 250.97 | 228.25 |

| | | S X | Cl XI | Ar XII | K XIII | Ca XIV | Sc XV | Ti XVI | V XVII | Cr XVIII |
|---|---|---|---|---|---|---|---|---|---|---|
| $2s^2 2p - 2s2p^4$ | $^4S^0_{3/2} - {}^4P_{1/2}$ | 257.15 | 234.84 | 215.49 | 198.52 | 183.46 | (169.95) | (157.78) | (146.69) | (136.56) |
| | $^4S^0_{3/2} - {}^4P_{3/2}$ | 259.52 | 237.42 | 218.29 | 201.47 | 186.62 | (173.25) | (161.25) | (150.24) | (140.19) |
| | $^4S^0_{3/2} - {}^4P_{5/2}$ | 264.24 | 242.76 | 224.25 | 208.11 | 193.88 | (181.19) | (169.78) | (159.46) | (150.04) |
| | $^2P^0_{1/2} - {}^2S_{1/2}$ | 207.53 | 190.94 | 176.58 | 163.99 | 152.99 | (145.56) | (137.55) | (130.21) | (123.61) |
| | $^2P^0_{3/2} - {}^2S_{1/2}$ | 208.33 | 192.06 | 178.15 | 165.96 | 155.42 | (148.15) | (140.25) | (133.16) | (126.74) |

Note: Transitions in Angstroms. ( ) indicates prediction.

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE

1S2 2S2 2P4( ) G 3P 0

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 226.977 | 210 |
| F | 2 | 9 | 490.6 | 487 |
| NE | 3 | 10 | 922. | 057 |
| NA | 4 | 11 | 1576. | 487 |
| MG | 5 | 12 | 2519. | 487 |
| AL | 6 | 13 | 3831. | 487 |
| SI | 7 | 14 | 5570. | 487 |
| P | 8 | 15 | 7826. | 487 |
| S | 9 | 16 | 10630. | 487 |
| CL | 10 | 17 | 14130. | 160 |
| AR | 11 | 18 | 18280. | 160 |
| K | 12 | 19 | 23240. | 161 |
| CA | 13 | 20 | 28830. | 269 |
| CA | 13 | 20 | 29053. | 160 |
| SC | 14 | 21 | (36200.) | 374 |
| TI | 15 | 22 | (44800.) | 374 |
| V | 16 | 23 | (54900.) | 374 |
| CR | 17 | 24 | (66700.) | 374 |

1S2 2S2 2P4( ) G 3P 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 158.265 | 210 |
| F | 2 | 9 | 341.8 | 487 |
| NE | 3 | 10 | 642.9 | 487 |
| NA | 4 | 11 | 1106. | 487 |
| MG | 5 | 12 | 1780. | 487 |
| AL | 6 | 13 | 2736. | 487 |
| SI | 7 | 14 | 4030. | 487 |
| P | 8 | 15 | 5757. | 487 |
| S | 9 | 16 | 7970. | 487 |
| CL | 10 | 17 | 10880. | 487 |
| AR | 11 | 18 | 14470. | 160 |
| K | 12 | 19 | 18990. | 161 |
| CA | 13 | 20 | 24410. | 269 |
| CA | 13 | 20 | 24300. | 160 |
| SC | 14 | 21 | (31200.) | 374 |
| TI | 15 | 22 | (39300.) | 374 |
| V | 16 | 23 | (48900.) | 374 |
| CR | 17 | 24 | (60200.) | 374 |

1S2 2S2 2P4( ) 1S 0

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 33792.583 | 210 |
| F | 2 | 9 | 44919. | 487 |
| NE | 3 | 10 | 55747. | 487 |
| NA | 4 | 11 | *66492.* | 487 |
| MG | 5 | 12 | *77254.* | 487 |
| AL | 6 | 13 | *88210.* | 487 |
| SI | 7 | 14 | *99330.* | 487 |
| P | 8 | 15 | *110970.* | 487 |
| S | 9 | 16 | *122300.* | 487 |
| CL | 10 | 17 | *130310.* | 487 |
| AR | 11 | 18 | (143000.) | 374 |
| K | 12 | 19 | *138000.* | 269 |
| K | 12 | 19 | (154000.) | 374 |
| CA | 13 | 20 | *149135.* | 269 |
| CA | 13 | 20 | (165000.) | 374 |
| SC | 14 | 21 | (175000.) | 374 |

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4(        )    1D 2

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 15867.862 | 210 |
| F | 2 | 9 | 20873. | 487 |
| NE | 3 | 10 | 25840.8 | 487 |
| NA | 4 | 11 | *30830.* | 487 |
| MG | 5 | 12 | *35890.* | 487 |
| AL | 6 | 13 | *41140.* | 487 |
| SI | 7 | 14 | *46550.* | 487 |
| P | 8 | 15 | *52450.* | 487 |
| S | 9 | 16 | *58000.* | 487 |
| CL | 10 | 17 | *61000.* | 487 |
| CL | 10 | 17 | (62600.) | 374 |
| AR | 11 | 18 | *62730.* | 160 |
| AR | 11 | 18 | (67900.) | 374 |
| K | 12 | 19 | *80600.* | 161 |
| K | 12 | 19 | (73200.) | 374 |
| CA | 13 | 20 | *89353.* | 160 |
| CA | 13 | 20 | (78400.) | 374 |

1S2 2S 2P5(        )    3P* 0

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 126383.751 | 210 |
| F | 2 | 9 | 165281.0 | 487 |
| NE | 3 | 10 | 205199. | 057 |
| NA | 4 | 11 | 245238. | 487 |
| MG | 5 | 12 | 285708. | 487 |
| AL | 6 | 13 | 326822. | 487 |
| SI | 7 | 14 | 368760. | 487 |
| P | 8 | 15 | 411736. | 487 |
| S | 9 | 16 | 455830. | 372 |
| CL | 10 | 17 | 501510. | 160 |
| AR | 11 | 18 | 549000. | 160 |
| K | 12 | 19 | 598460. | 161 |
| CA | 13 | 20 | 650120. | 269 |
| SC | 14 | 21 | (704700.) | 374 |
| TI | 15 | 22 | (762500.) | 374 |
| V | 16 | 23 | (823500.) | 374 |
| CR | 17 | 24 | (889000.) | 374 |

1S2 2S 2P5(        )    3P* 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 126340.225 | 210 |
| F | 2 | 9 | 165107.1 | 487 |
| NE | 3 | 10 | 204876. | 057 |
| NA | 4 | 11 | 244688. | 487 |
| MG | 5 | 12 | 284827. | 487 |
| AL | 6 | 13 | 325470. | 487 |
| SI | 7 | 14 | 366780. | 487 |
| P | 8 | 15 | 408913. | 487 |
| S | 9 | 16 | 451930. | 372 |
| CL | 10 | 17 | 496260. | 160 |
| AR | 11 | 18 | 541960. | 160 |
| K | 12 | 19 | 589230. | 161 |
| CA | 13 | 20 | 638240. | 269 |
| SC | 14 | 21 | (689600.) | 374 |
| TI | 15 | 22 | (743500.) | 374 |
| V | 16 | 23 | (800000.) | 374 |
| CR | 17 | 24 | (860000.) | 374 |

TABLE XIII   OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S 2P5(   )   3P* 2

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 126266.896 | 210 |
| F | 2 | 9 | 164797.7 | 487 |
| NE | 3 | 10 | 204290. | 057 |
| NA | 4 | 11 | 243682. | 487 |
| MG | 5 | 12 | 283211. | 487 |
| AL | 6 | 13 | 323002. | 487 |
| SI | 7 | 14 | 363170. | 487 |
| P | 8 | 15 | 403806. | 487 |
| S | 9 | 16 | 444900. | 372 |
| CL | 10 | 17 | 486850. | 160 |
| AR | 11 | 18 | 529670. | 160 |
| K | 12 | 19 | 573410. | 161 |
| CA | 13 | 20 | 618240. | 269 |
| SC | 14 | 21 | (664700.) | 374 |
| TI | 15 | 22 | (713000.) | 374 |
| V | 16 | 23 | (763000.) | 374 |
| CR | 17 | 24 | (815000.) | 374 |

1S2 2S 2P5(   )   1P* 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 189837. | 487 |
| F | 2 | 9 | 239605.0 | 487 |
| NE | 3 | 10 | 289479. | 487 |
| NA | 4 | 11 | *343684.* | 487 |
| MG | 5 | 12 | *397448.* | 487 |
| AL | 6 | 13 | *451380.* | 487 |
| SI | 7 | 14 | *505630.* | 487 |
| P | 8 | 15 | *560680.* | 487 |
| S | 9 | 16 | *615820.* | 372 |
| CL | 10 | 17 | *668850.* | 160 |
| AR | 11 | 18 | *721220.* | 160 |
| K | 12 | 19 | *790500.* | 161 |
| CA | 13 | 20 | *851430.* | 269 |
| SC | 14 | 21 | (926000.) | 374 |
| TI | 15 | 22 | (1010000.) | 374 |
| V | 16 | 23 | (1107000.) | 374 |
| CR | 17 | 24 | (1221000.) | 374 |

1S2 2S2 2P3( 4S* ) 3S   3S* 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 76794.978 | 210 |
| F | 2 | 9 | 182865.2 | 487 |
| NE | 3 | 10 | 319442.00 | 057 |
| NA | 4 | 11 | 486648. | 487 |
| MG | 5 | 12 | 684544. | 487 |
| AL | 6 | 13 | 913130. | 487 |
| SI | 7 | 14 | 1172470. | 487 |
| P | 8 | 15 | 1462340. | 487 |
| S | 9 | 16 | 1783150. | 487 |
| CL | 10 | 17 | 2134700. | 487 |
| AR | 11 | 18 | 2516400. | 255 |
| K | 12 | 19 | (2929000.) | 374 |
| CA | 13 | 20 | (3373000.) | 374 |
| SC | 14 | 21 | (3847000.) | 374 |
| TI | 15 | 22 | (4351000.) | 374 |

TABLE XIII   OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3( 2P* ) 3S   3P* 0

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 113927.534 | 210 |
| F | 2 | 9 | 229555.10 | 487 |
| NE | 3 | 10 | 374474.66 | 057 |
| NA | 4 | 11 | 550176. | 487 |
| MG | 5 | 12 | (756450.) | 374 |
| AL | 6 | 13 | (993600.) | 374 |
| SI | 7 | 14 | (1261400.) | 374 |
| P | 8 | 15 | 1559500. | 487 |
| S | 9 | 16 | (1888000.) | 374 |
| CL | 10 | 17 | (2247000.) | 374 |
| AR | 11 | 18 | (2636000.) | 374 |

1S2 2S2 2P3( 2P* ) 3S   3P* 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 113921.391 | 210 |
| F | 2 | 9 | 229552.44 | 487 |
| NE | 3 | 10 | 374457.75 | 057 |
| NA | 4 | 11 | 550176. | 487 |
| MG | 5 | 12 | 756536. | 487 |
| AL | 6 | 13 | 993660. | 487 |
| SI | 7 | 14 | 1261610. | 487 |
| P | 8 | 15 | 1560070. | 487 |
| S | 9 | 16 | (1889000.) | 374 |
| CL | 10 | 17 | (2248500.) | 374 |
| AR | 11 | 18 | (2638000.) | 374 |

1S2 2S2 2P3( 2P* ) 3S   3P* 2

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 113910.957 | 210 |
| F | 2 | 9 | 229550.83 | 487 |
| NE | 3 | 10 | 374431.00 | 057 |
| NA | 4 | 11 | 550176. | 487 |
| MG | 5 | 12 | 756589. | 487 |
| AL | 6 | 13 | 993880. | 487 |
| SI | 7 | 14 | 1262040. | 487 |
| P | 8 | 15 | 1561260. | 487 |
| S | 9 | 16 | (1891000.) | 374 |
| CL | 10 | 17 | (2251000.) | 374 |
| AR | 11 | 18 | (2642000.) | 374 |

1S2 2S2 2P3( 2P* ) 3S   1P* 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 115918.143 | 210 |
| F | 2 | 9 | 227228.2 | 487 |
| NE | 3 | 10 | 379834. | 487 |
| NA | 4 | 11 | *556793.* | 487 |
| MG | 5 | 12 | *764591.* | 487 |
| AL | 6 | 13 | *1003240.* | 487 |
| SI | 7 | 14 | *1272720.* | 487 |
| P | 8 | 15 | *1573270.* | 487 |
| S | 9 | 16 | *1904040.* | 487 |
| CL | 10 | 17 | *2262140.* | 487 |
| AR | 11 | 18 | (2653000.) | 374 |
| K | 12 | 19 | (3074000.) | 374 |
| CA | 13 | 20 | (3525000.) | 374 |
| SC | 14 | 21 | (4008000.) | 374 |

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3( 2D* ) 3S 3D* 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 101155.422 | 210 |
| F | 2 | 9 | 211900.72 | 487 |
| NE | 3 | 10 | 353194.40 | 057 |
| NA | 4 | 11 | 525136. | 487 |
| MG | 5 | 12 | 727787. | 487 |
| AL | 6 | 13 | 961100. | 487 |
| SI | 7 | 14 | 1225150. | 487 |
| P | 8 | 15 | 1519740. | 487 |
| S | 9 | 16 | (1846720.) | 375 |
| CL | 10 | 17 | 2202610. | 487 |
| AR | 11 | 18 | (2589000.) | 374 |
| K | 12 | 19 | (3007000.) | 374 |
| CA | 13 | 20 | (3455000.) | 374 |

1S2 2S2 2P3( 2D* ) 3S 3D* 2

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 101147.526 | 210 |
| F | 2 | 9 | 211887.69 | 487 |
| NE | 3 | 10 | 353174.16 | 057 |
| NA | 4 | 11 | 525119. | 487 |
| MG | 5 | 12 | 727763. | 487 |
| AL | 6 | 13 | 961100. | 487 |
| SI | 7 | 14 | 1225150. | 487 |
| P | 8 | 15 | 1519740. | 487 |
| S | 9 | 16 | 1846340. | 487 |
| CL | 10 | 17 | 2202610. | 487 |
| AR | 11 | 18 | (2589000.) | 374 |
| K | 12 | 19 | (3007000.) | 374 |
| CA | 13 | 20 | (3455000.) | 374 |

1S2 2S2 2P3( 2D* ) 3S 3D* 3

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 101135.407 | 210 |
| F | 2 | 9 | 211866.62 | 487 |
| NE | 3 | 10 | 353145. | 057 |
| NA | 4 | 11 | 525100. | 487 |
| MG | 5 | 12 | 727718. | 487 |
| AL | 6 | 13 | 961100. | 487 |
| SI | 7 | 14 | 1225150. | 487 |
| P | 8 | 15 | 1520030. | 487 |
| S | 9 | 16 | 1845770. | 487 |
| CL | 10 | 17 | 2202610. | 487 |
| AR | 11 | 18 | (2589000.) | 374 |
| K | 12 | 19 | (3007000.) | 374 |
| CA | 13 | 20 | (3455000.) | 374 |

1S2 2S2 2P3( 2D* ) 3S 1D* 2

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 102662.026 | 210 |
| F | 2 | 9 | 215069.8 | 487 |
| NE | 3 | 10 | 357930. | 487 |
| NA | 4 | 11 | *531408.* | 487 |
| MG | 5 | 12 | *735518.* | 487 |
| AL | 6 | 13 | *970330.* | 487 |
| SI | 7 | 14 | *1235870.* | 487 |
| P | 8 | 15 | *1532020.* | 487 |
| S | 9 | 16 | *1858500.* | 487 |
| CL | 10 | 17 | *2212650.* | 487 |
| AR | 11 | 18 | *2594300.* | 255 |
| K | 12 | 19 | (3013000.) | 374 |
| CA | 13 | 20 | (3459000.) | 374 |
| SC | 14 | 21 | (3936000.) | 374 |

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3( 2D* ) 3D 3S* 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | (123900.) | 374 |
| F | 2 | 9 | 266360.69 | 487 |
| NE | 3 | 10 | 440064.90 | 487 |
| NA | 4 | 11 | 644140. | 487 |
| MG | 5 | 12 | 879485. | 487 |
| AL | 6 | 13 | 1145020. | 487 |
| SI | 7 | 14 | 1441230. | 487 |
| P | 8 | 15 | 1767880. | 487 |
| S | 9 | 16 | 2125310. | 487 |
| CL | 10 | 17 | (2513000.) | 374 |
| AR | 11 | 18 | (2933000.) | 374 |
| K | 12 | 19 | (3383000.) | 374 |

1S2 2S2 2P3( 2P* ) 3D 3P* 0

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | (138400.) | 374 |
| F | 2 | 9 | 282897.0 | 487 |
| NE | 3 | 10 | (457800.) | 374 |
| NA | 4 | 11 | 663592. | 487 |
| MG | 5 | 12 | 898673. | 487 |
| AL | 6 | 13 | 1164220. | 487 |
| SI | 7 | 14 | 1460290. | 487 |
| P | 8 | 15 | 1787090. | 487 |
| S | 9 | 16 | (2143800.) | 374 |
| CL | 10 | 17 | (2531000.) | 374 |
| AR | 11 | 18 | (2948000.) | 374 |

1S2 2S2 2P3( 2P* ) 3D 3P* 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | (138400.) | 374 |
| F | 2 | 9 | 282913.4 | 487 |
| NE | 3 | 10 | (457800.) | 374 |
| NA | 4 | 11 | 663592. | 487 |
| MG | 5 | 12 | 898904. | 487 |
| AL | 6 | 13 | 1164620. | 487 |
| SI | 7 | 14 | 1460860. | 487 |
| P | 8 | 15 | 1788090. | 487 |
| S | 9 | 16 | 2144820. | 487 |
| CL | 10 | 17 | (2532500.) | 374 |
| AR | 11 | 18 | (2950000.) | 374 |

1S2 2S2 2P3( 2P* ) 3D 3P* 2

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | (138400.) | 374 |
| F | 2 | 9 | 282947.9 | 487 |
| NE | 3 | 10 | (457800.) | 374 |
| NA | 4 | 11 | 663592. | 487 |
| MG | 5 | 12 | 899291. | 487 |
| AL | 6 | 13 | 1165260. | 487 |
| SI | 7 | 14 | 1461860. | 487 |
| P | 8 | 15 | 1789690. | 487 |
| S | 9 | 16 | 2146610. | 487 |
| CL | 10 | 17 | (2535000.) | 374 |
| AR | 11 | 18 | (2953000.) | 374 |

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3( 2P* ) 3D 1P* 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | (140000.) | 374 |
| F | 2 | 9 | 284224.8 | 487 |
| NE | 3 | 10 | (459200.) | 374 |
| NA | 4 | 11 | *665352.* | 487 |
| MG | 5 | 12 | *902449.* | 487 |
| AL | 6 | 13 | *1170590.* | 487 |
| SI | 7 | 14 | *1470040.* | 487 |
| P | 8 | 15 | *1800760.* | 487 |
| S | 9 | 16 | *2162470.* | 487 |
| CL | 10 | 17 | (2555000.) | 374 |
| AR | 11 | 18 | (2979000.) | 374 |

1S2 2S2 2P3( 2D* ) 3D 3P* 0

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 123387.339 | 210 |
| F | 2 | 9 | 266516.35 | 487 |
| NE | 3 | 10 | 439760.35 | 487 |
| NA | 4 | 11 | 643396. | 487 |
| MG | 5 | 12 | 877444. | 487 |
| AL | 6 | 13 | 1141910. | 487 |
| SI | 7 | 14 | 1437090. | 487 |
| P | 8 | 15 | (1763000.) | 374 |
| S | 9 | 16 | (2120000.) | 374 |
| CL | 10 | 17 | (2507000.) | 374 |
| AR | 11 | 18 | (2927000.) | 374 |
| K | 12 | 19 | (3377000.) | 374 |

1S2 2S2 2P3( 2D* ) 3D 3P* 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 123355.512 | 210 |
| F | 2 | 9 | 266499.12 | 487 |
| NE | 3 | 10 | 439707.81 | 487 |
| NA | 4 | 11 | 643304. | 487 |
| MG | 5 | 12 | 877244. | 487 |
| AL | 6 | 13 | 1141670. | 487 |
| SI | 7 | 14 | 1436750. | 487 |
| P | 8 | 15 | 1762400. | 487 |
| S | 9 | 16 | 2119180. | 487 |
| CL | 10 | 17 | (2506000.) | 374 |
| AR | 11 | 18 | (2925000.) | 374 |
| K | 12 | 19 | (3375000.) | 374 |

1S2 2S2 2P3( 2D* ) 3D 3P* 2

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 123296.777 | 210 |
| F | 2 | 9 | 266454.27 | 487 |
| NE | 3 | 10 | 439586.00 | 487 |
| NA | 4 | 11 | 643029. | 487 |
| MG | 5 | 12 | 876762. | 487 |
| AL | 6 | 13 | 1140840. | 487 |
| SI | 7 | 14 | 1435460. | 487 |
| P | 8 | 15 | 1760530. | 487 |
| S | 9 | 16 | 2116450. | 487 |
| CL | 10 | 17 | 2502750. | 487 |
| AR | 11 | 18 | 2920600. | 255 |
| K | 12 | 19 | (3369000.) | 374 |

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3( 2D* ) 3D 1P* 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | (126000.) | 374 |
| F | 2 | 9 | 267400.3 | 487 |
| NE | 3 | 10 | (439000.) | 374 |
| NA | 4 | 11 | *641180.* | 487 |
| MG | 5 | 12 | *873404.* | 487 |
| AL | 6 | 13 | *1136040.* | 487 |
| SI | 7 | 14 | *1429230.* | 487 |
| P | 8 | 15 | *1753830.* | 487 |
| S | 9 | 16 | (2111000.) | 374 |
| CL | 10 | 17 | (2501000.) | 374 |

1S2 2S2 2P3( 4S* ) 3D 3D* 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 97488.378 | 210 |
| F | 2 | 9 | 232064.18 | 487 |
| NE | 3 | 10 | 398189.80 | 057 |
| NA | 4 | 11 | 594893. | 487 |
| MG | 5 | 12 | 821963. | 487 |
| AL | 6 | 13 | 1079460. | 487 |
| SI | 7 | 14 | 1367360. | 487 |
| P | 8 | 15 | 1685980. | 487 |
| S | 9 | 16 | 2035220. | 487 |
| CL | 10 | 17 | 2415000. | 374 |
| AR | 11 | 18 | 2843300. | 255 |
| K | 12 | 19 | (3301000.) | 374 |
| CA | 13 | 20 | (3798000.) | 374 |

1S2 2S2 2P3( 4S* ) 3D 3D* 2

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 97488.431 | 210 |
| F | 2 | 9 | 232064.98 | 487 |
| NE | 3 | 10 | 398193.93 | 057 |
| NA | 4 | 11 | 594898. | 487 |
| MG | 5 | 12 | 821977. | 487 |
| AL | 6 | 13 | 1079490. | 487 |
| SI | 7 | 14 | 1367460. | 487 |
| P | 8 | 15 | 1685980. | 487 |
| S | 9 | 16 | 2035220. | 487 |
| CL | 10 | 17 | 2415360. | 487 |
| AR | 11 | 18 | 2838900. | 255 |
| K | 12 | 19 | (3301000.) | 374 |
| CA | 13 | 20 | (3798000.) | 374 |

1S2 2S2 2P3( 4S* ) 3D 3D* 3

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 97488.523 | 210 |
| F | 2 | 9 | 232067.06 | 487 |
| NE | 3 | 10 | 398207.84 | 057 |
| NA | 4 | 11 | 594941. | 487 |
| MG | 5 | 12 | 822071. | 487 |
| AL | 6 | 13 | 1079610. | 487 |
| SI | 7 | 14 | 1367560. | 487 |
| P | 8 | 15 | 1686280. | 487 |
| S | 9 | 16 | 2035870. | 487 |
| CL | 10 | 17 | 2416040. | 487 |
| AR | 11 | 18 | 2825700. | 255 |
| K | 12 | 19 | (3301000.) | 374 |
| CA | 13 | 20 | (3798000.) | 374 |

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3( 2P* ) 3D 3D* 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | (150000.) | 374 |
| F | 2 | 9 | (288000.) | 374 |
| NE | 3 | 10 | (460000.) | 374 |
| NA | 4 | 11 | 665362. | 487 |
| MG | 5 | 12 | 902682. | 487 |
| AL | 6 | 13 | (1171000.) | 374 |
| SI | 7 | 14 | (1471000.) | 374 |
| P | 8 | 15 | (1802000.) | 374 |
| S | 9 | 16 | (2166000.) | 374 |
| CL | 10 | 17 | (2564000.) | 374 |
| AR | 11 | 18 | (2994000.) | 374 |

1S2 2S2 2P3( 2P* ) 3D 3D* 2

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | (150000.) | 374 |
| F | 2 | 9 | (288000.) | 374 |
| NE | 3 | 10 | (460000.) | 374 |
| NA | 4 | 11 | 665362. | 487 |
| MG | 5 | 12 | 902441. | 487 |
| AL | 6 | 13 | 1170650. | 487 |
| SI | 7 | 14 | 1470050. | 487 |
| P | 8 | 15 | 1800770. | 487 |
| S | 9 | 16 | (2163000.) | 374 |
| CL | 10 | 17 | (2558000.) | 374 |
| AR | 11 | 18 | (2987000.) | 374 |

1S2 2S2 2P3( 2P* ) 3D 3D* 3

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | (150000.) | 374 |
| F | 2 | 9 | (288000.) | 374 |
| NE | 3 | 10 | (460000.) | 374 |
| NA | 4 | 11 | 665362. | 487 |
| MG | 5 | 12 | 902047. | 487 |
| AL | 6 | 13 | 1169390. | 487 |
| SI | 7 | 14 | 1467390. | 487 |
| P | 8 | 15 | 1796240. | 487 |
| S | 9 | 16 | 2156430. | 487 |
| CL | 10 | 17 | 2547580. | 487 |
| AR | 11 | 18 | (2974000.) | 374 |

1S2 2S2 2P3( 2P* ) 3D 1D* 2

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | (140000.) | 374 |
| F | 2 | 9 | 282774.7 | 487 |
| NE | 3 | 10 | (458000.) | 374 |
| NA | 4 | 11 | *664616.* | 487 |
| MG | 5 | 12 | *901414.* | 487 |
| AL | 6 | 13 | *1168690.* | 487 |
| SI | 7 | 14 | *1466460.* | 487 |
| P | 8 | 15 | *1795430.* | 487 |
| S | 9 | 16 | (2154000.) | 374 |
| CL | 10 | 17 | (2544000.) | 374 |
| AR | 11 | 18 | (2964000.) | 374 |

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3( 2D* ) 3D 3D* 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | (124000.) | 374 |
| F | 2 | 9 | 265517.14 | 487 |
| NE | 3 | 10 | 436963.49 | 057 |
| NA | 4 | 11 | 638977. | 487 |
| MG | 5 | 12 | 871221. | 487 |
| AL | 6 | 13 | 1134170. | 487 |
| P | 8 | 15 | 1753090. | 487 |
| S | 9 | 16 | 2108190. | 487 |
| CL | 10 | 17 | 2494700. | 487 |
| AR | 11 | 18 | 2928800. | 255 |
| K | 12 | 19 | (3359000.) | 374 |
| CA | 13 | 20 | (3837000.) | 374 |
| SC | 14 | 21 | (4346000.) | 374 |

1S2 2S2 2P3( 2D* ) 3D 3D* 2

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | (124000.) | 374 |
| F | 2 | 9 | 265498.74 | 487 |
| NE | 3 | 10 | 436918.39 | 057 |
| NA | 4 | 11 | 638942. | 487 |
| MG | 5 | 12 | 871221. | 487 |
| AL | 6 | 13 | 1134170. | 487 |
| SI | 7 | 14 | 1428090. | 487 |
| P | 8 | 15 | 1753090. | 487 |
| S | 9 | 16 | 2108190. | 487 |
| CL | 10 | 17 | 2494700. | 487 |
| AR | 11 | 18 | 2924400. | 255 |
| K | 12 | 19 | (3359000.) | 374 |
| CA | 13 | 20 | (3837000.) | 374 |
| SC | 14 | 21 | (4346000.) | 374 |

1S2 2S2 2P3( 2D* ) 3D 3D* 3

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | (124000.) | 374 |
| F | 2 | 9 | 265472.70 | 487 |
| NE | 3 | 10 | 436841.63 | 057 |
| NA | 4 | 11 | 638831. | 487 |
| MG | 5 | 12 | 871221. | 487 |
| AL | 6 | 13 | 1134170. | 487 |
| SI | 7 | 14 | 1428020. | 487 |
| P | 8 | 15 | 1753090. | 487 |
| S | 9 | 16 | 2108190. | 487 |
| CL | 10 | 17 | 2494700. | 487 |
| AR | 11 | 18 | 2911200. | 255 |
| K | 12 | 19 | (3359000.) | 374 |
| CA | 13 | 20 | (3837000.) | 374 |
| SC | 14 | 21 | (4346000.) | 374 |

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3( 2D* ) 3D 1D* 2

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 124319.175 | 210 |
| F | 2 | 9 | 266270.2 | 487 |
| NE | 3 | 10 | 440000. | 374 |
| NA | 4 | 11 | 643624. | 487 |
| MG | 5 | 12 | 877570. | 487 |
| AL | 6 | 13 | 1141760. | 487 |
| SI | 7 | 14 | 1436310. | 487 |
| P | 8 | 15 | 1761680. | 487 |
| S | 9 | 16 | 2117140. | 487 |
| CL | 10 | 17 | 2500380. | 487 |
| AR | 11 | 18 | 2917000. | 374 |
| K | 12 | 19 | 3363000. | 374 |
| CA | 13 | 20 | 3841000. | 374 |
| SC | 14 | 21 | 4350000. | 374 |

1S2 2S2 2P3( 2D* ) 3D 3F* 2

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 124224.118 | 210 |
| F | 2 | 9 | 264953.12 | 487 |
| NE | 3 | 10 | 435522.9 | 057 |
| NA | 4 | 11 | 637000. | 374 |
| MG | 5 | 12 | 869000. | 374 |
| AL | 6 | 13 | 1132180. | 487 |
| SI | 7 | 14 | 1426050. | 487 |
| P | 8 | 15 | 1749870. | 487 |
| S | 9 | 16 | 2105000. | 374 |
| CL | 10 | 17 | 2490000. | 374 |
| AR | 11 | 18 | 2910000. | 374 |
| K | 12 | 19 | 3353000. | 374 |

1S2 2S2 2P3( 2D* ) 3D 3F* 3

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 124219.025 | 210 |
| F | 2 | 9 | 264958.63 | 487 |
| NE | 3 | 10 | 435569.0 | 057 |
| NA | 4 | 11 | 637000. | 374 |
| MG | 5 | 12 | 869000. | 374 |
| AL | 6 | 13 | 1132180. | 487 |
| SI | 7 | 14 | 1426050. | 487 |
| P | 8 | 15 | 1749870. | 487 |
| S | 9 | 16 | 2105000. | 374 |
| CL | 10 | 17 | 2490000. | 374 |
| AR | 11 | 18 | 2910000. | 374 |
| K | 12 | 19 | 3353000. | 374 |

1S2 2S2 2P3( 2D* ) 3D 3F* 4

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 124213.18 | 487 |
| O | 1 | 8 | 124213.607 | 210 |
| F | 2 | 9 | 264965.91 | 487 |
| NE | 3 | 10 | 435617.8 | 057 |
| NA | 4 | 11 | 637000. | 374 |
| MG | 5 | 12 | 869000. | 374 |
| SI | 7 | 14 | 1426050. | 487 |
| P | 8 | 15 | 1749870. | 487 |
| S | 9 | 16 | 2105000. | 374 |
| CL | 10 | 17 | 2490000. | 374 |
| AR | 11 | 18 | 2910000. | 374 |
| K | 12 | 19 | 3353000. | 374 |

TABLE XIII OXYGEN ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P3( 2D* ) 3D 1F* 3

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 124326.779 | 210 |
| F | 2 | 9 | 266548.7 | 487 |
| NE | 3 | 10 | (442000.) | 374 |
| NA | 4 | 11 | *646423.* | 487 |
| MG | 5 | 12 | *882752.* | 487 |
| AL | 6 | 13 | *1149790.* | 487 |
| SI | 7 | 14 | *1447420.* | 487 |
| P | 8 | 15 | *1776050.* | 487 |
| S | 9 | 16 | *2134410.* | 487 |
| CL | 10 | 17 | *2520420.* | 487 |
| AR | 11 | 18 | (2942000.) | 374 |
| K | 12 | 19 | (3392000.) | 374 |

1S2 2S2 2P3( 2P* ) 3D 1F* 3

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | (138000.) | 374 |
| F | 2 | 9 | 283409.4 | 487 |
| NE | 3 | 10 | (460000.) | 374 |
| NA | 4 | 11 | *667408.* | 487 |
| MG | 5 | 12 | *904753.* | 487 |
| AL | 6 | 13 | *1173990.* | 487 |
| SI | 7 | 14 | *1473650.* | 487 |
| P | 8 | 15 | *1804930.* | 487 |
| S | 9 | 16 | (2166000.) | 374 |
| CL | 10 | 17 | (2559000.) | 374 |
| AR | 11 | 18 | (2983000.) | 374 |

1S2 2S2 2P3( 4S* ) 4S 3S* 1

| | | | | |
|---|---|---|---|---|
| O | 1 | 8 | 96225.049 | 210 |
| F | 2 | 9 | 236961.63 | 487 |
| NE | 3 | 10 | (420000.) | 374 |
| NA | 4 | 11 | 644792. | 487 |
| MG | 5 | 12 | 910639. | 487 |
| AL | 6 | 13 | 1218290. | 487 |
| SI | 7 | 14 | (1567300.) | 374 |
| P | 8 | 15 | 1958370. | 487 |
| S | 9 | 16 | (2392300.) | 374 |
| CL | 10 | 17 | (2870000.) | 374 |

TABLE XIV

TRANSITIONS - OXYGEN ISOELECTRONIC SEQUENCE

| | | O I | F II | Ne III | Na IV | Mg V | Al VI | Si VII | P VIII | S IX |
|---|---|---|---|---|---|---|---|---|---|---|
| $2p^4 - 2p^3(^2D^o)3s$ | $^3P_2 - ^3D^o_3$ | 988.77 | 472.00 | 283.17 | 190.44 | 137.42 | 104.05 | 81.62 | 65.79 | 54.18 |
| | $^1D_2 - ^1D^o_2$ | 1152.15 | 514.94 | 301.12 | 199.76 | 142.93 | 107.62 | 84.08 | 67.59 | 55.54 |
| $2p^4 - 2p^3(^2D^o)3d$ | $^3P_2 - ^3S^o_1$ | (807.10) | 375.43 | 227.24 | 155.26 | 113.70 | 87.33 | 69.39 | 56.56 | 47.05 |
| | $^3P_2 - ^3D^o_3$ | (806.45) | 376.69 | 228.92 | 156.54 | 114.78 | 88.17 | 70.03 | 57.04 | 47.43 |
| | $^1S_0 - ^1P^o_1$ | (1084.51) | 449.48 | (260.92) | 174.01 | 125.60 | 95.43 | 75.19 | 60.87 | (50.28) |
| | $^1D_2 - ^1P^o_1$ | (908.00) | 405.63 | (242.04) | 163.84 | 119.40 | 91.33 | 72.32 | 58.77 | (48.71) |
| | $^1D_2 - ^1D^o_2$ | | 407.50 | (241.53) | 163.19 | 118.81 | 90.86 | 71.95 | 58.51 | 48.56 |
| | $^1D_2 - ^1F^o_3$ | | 407.04 | (240.29) | 162.44 | 118.08 | 90.20 | 71.38 | 58.02 | 48.16 |
| $2p^4 - 2p^3(^4S^o)3d$ | $^3P_2 - ^3D^o_3$ | 1025.76 | 430.91 | 251.13 | 168.08 | 121.64 | 92.63 | 73.12 | 59.30 | 49.12 |
| $2p^4 - 2p^3(^4S^o)4s$ | $^3P_2 - ^3S^o_1$ | 1039.23 | 422.01 | (238.10) | 155.09 | 109.81 | 82.08 | (63.80) | 51.06 | (41.80) |
| $2p^4 - 2s2p^5$ | $^1S_0 - ^1P^o_1$ | 640.84 | 513.65 | 427.84 | 360.76 | 312.31 | 275.35 | 246.12 | 222.37 | 202.63 |
| | $^1D_2 - ^1P^o_1$ | 574.81 | 457.81 | 379.30 | 319.64 | 276.58 | 243.76 | 217.83 | 196.76 | 179.27 |
| $2p^4 - 2p^3(^4S^o)3s$ | $^3P_2 - ^3S^o_1$ | 1302.17 | 546.85 | 313.05 | 205.49 | 146.08 | 109.51 | 85.29 | 68.38 | 56.08 |
| $2p^4 - 2p^3(^2P^o)3s$ | $^1S_0 - ^1P^o_1$ | 1217.65 | 548.52 | 308.56 | 203.96 | 145.49 | 109.29 | 85.22 | 68.39 | 56.12 |
| | $^1D_2 - ^1P^o_1$ | 999.45 | 484.60 | 282.49 | 190.13 | 137.13 | 103.94 | 81.55 | 65.75 | 54.17 |
| $2p^4 - 2p^3(^2P^o)3d$ | $^3P_2 - ^3D^o_3$ | (666.67) | (347.22) | (217.39) | 150.29 | 110.89 | 85.51 | 68.15 | 55.67 | 46.37 |
| | $^1D_2 - ^1D^o_2$ | (805.59) | 381.82 | (231.40) | 157.78 | 115.54 | 88.69 | 70.43 | 57.37 | (47.71) |
| | $^1D_2 - ^1F^o_3$ | (818.79) | 380.90 | (230.33) | 157.09 | 115.09 | 88.27 | 70.07 | 57.06 | (47.44) |

Note: Transitions in Angstroms. (      ) indicates prediction.

TABLE XIV

TRANSITIONS - OXYGEN ISOELECTRONIC SEQUENCE (continued)

| | | Cl X | Ar XI | K XII | Ca XIII | Sc XIV | Ti XV | V XVI | Cr XVII |
|---|---|---|---|---|---|---|---|---|---|
| $2p^4 - 2p^3(^2D^o)3s$ | $^3P_2 - ^3D^o_3$ | 45.40 | (38.62) | (33.25) | (28.94) | | | | |
| | $^1D_2 - ^1D^o_2$ | 46.48 | (39.58) | (34.10) | (29.58) | | | | |
| $2p^4 - 2p^3(^2D^o)3d$ | $^3P_2 - ^3S^o_1$ | (39.79) | (34.09) | (29.56) | | | | | |
| | $^3P_2 - ^3D^o_3$ | 40.08 | 35.35 | (29.77) | (26.06) | | | | |
| | $^1S_0 - ^1P^o_1$ | (42.18) | | | | | | | |
| | $^1D_2 - ^1P^o_1$ | (41.01) | | | | | | | |
| | $^1D_2 - ^1D^o_2$ | (41.02) | (35.10) | (30.47) | (26.57) | | | | |
| | $^1D_2 - ^1F^o_3$ | (41.20) | (34.79) | (30.19) | | | | | |
| $2p^4 - 2p^3(^4S^o)3d$ | $^3P_2 - ^3D^o_3$ | 41.39 | 35.39 | (30.30) | (26.33) | | | | |
| $2p^4 - 2p^3(^4S^o)4s$ | $^3P_2 - ^3S^o_1$ | (34.84) | | | | | | | |
| $2p^4 - 2s2p^5$ | $^1S_0 - ^1P^o_1$ | 185.69 | (172.94) | (157.11) | (145.68) | (133.16) | | | |
| | $^1D_2 - ^1P^o_1$ | (164.95) | (153.06) | (139.41) | (129.36) | | | | |
| $2p^4 - 2p^3(^4S^o)3s$ | $^3P_2 - ^3S^o_1$ | 46.84 | 39.74 | (34.14) | (29.65) | (25.99) | (22.98) | | |
| $2p^4 - 2p^3(^2P^o)3s$ | $^1S_0 - ^1P^o_1$ | 46.90 | (39.84) | (34.05) | (29.76) | (26.09) | | | |
| | $^1D_2 - ^1P^o_1$ | (45.46) | (38.68) | (33.41) | (29.11) | | | | |
| $2p^4 - 2p^3(^2P^o)3d$ | $^3P_2 - ^3D^o_3$ | 39.25 | (33.62) | | | | | | |
| | $^1D_2 - ^1D^o_2$ | (40.30) | (34.47) | | | | | | |
| | $^1D_2 - ^1F^o_3$ | (40.05) | (34.30) | | | | | | |

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE

1S2 2S2 2P5( ) G 2P* 1

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 404.10 | 420 |
| NE | 2 | 10 | 782. | PM68 |
| NA | 3 | 11 | 1364. | 487 |
| MG | 4 | 12 | 2226. | 487 |
| AL | 5 | 13 | 3440. | 487 |
| SI | 6 | 14 | 5100. | 487 |
| P | 7 | 15 | 7268. | 487 |
| S | 8 | 16 | (10110.) | 375 |
| CL | 9 | 17 | 13600. | 487 |
| AR | 10 | 18 | (18110.) | 375 |
| K | 11 | 19 | 23480. | 269 |
| CA | 12 | 20 | 29940. | 269 |
| SC | 13 | 21 | (37700.) | 375 |
| TI | 14 | 22 | 46800. | 269 |
| V | 15 | 23 | (57300.) | 374 |
| CR | 16 | 24 | (69600.) | 374 |
| MN | 17 | 25 | (83600.) | 374 |
| FE | 18 | 26 | (99700.) | 374 |
| CO | 19 | 27 | (118000.) | 374 |
| NI | 20 | 28 | (138000.) | 374 |
| CU | 21 | 29 | (161000.) | 374 |
| ZN | 22 | 30 | (187000.) | 374 |

1S2 2S 2P6( ) 2S 1

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 169824.50 | 420 |
| NE | 2 | 10 | 217050. | 487 |
| NA | 3 | 11 | 264449. | 487 |
| MG | 4 | 12 | 311527. | 487 |
| AL | 5 | 13 | 358810. | 487 |
| SI | 6 | 14 | 406500. | 487 |
| P | 7 | 15 | 454732. | 487 |
| S | 8 | 16 | 503650. | 598 |
| CL | 9 | 17 | 553400. | 487 |
| AR | 10 | 18 | 603970. | 255 |
| K | 11 | 19 | 655940. | 269 |
| CA | 12 | 20 | 708970. | 269 |
| SC | 13 | 21 | 763590. | 269 |
| TI | 14 | 22 | 819600. | 269 |
| V | 15 | 23 | (877300.) | 375 |
| CR | 16 | 24 | (936700.) | 375 |
| MN | 17 | 25 | (998000.) | 375 |
| FE | 18 | 26 | (1061000.) | 375 |
| CO | 19 | 27 | (1126000.) | 375 |
| NI | 20 | 28 | (1195000.) | 374 |
| CU | 21 | 29 | (1265000.) | 374 |
| ZN | 22 | 30 | (1337000.) | 374 |

1S2 2S2 2P4( 1S ) 3S 2S 1

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 148984. | 420 |
| NE | 2 | 10 | 276679.49 | PM68 |
| NA | 3 | 11 | 435031. | 487 |
| MG | 4 | 12 | 624102. | 487 |
| AL | 5 | 13 | 843880. | 487 |
| SI | 6 | 14 | 1094460. | 487 |
| P | 7 | 15 | 1375810. | 487 |
| S | 8 | 16 | 1688170. | 487 |
| CL | 9 | 17 | 2031080. | 487 |
| AR | 10 | 18 | 2406200. | 255 |
| K | 11 | 19 | (2795000.) | 374 |
| CA | 12 | 20 | (3220000.) | 374 |
| SC | 13 | 21 | (3673000.) | 374 |

1S2 2S2 2P4( 3P ) 3S 4P 1

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 102840.38 | 420 |
| NE | 2 | 10 | 219949.77 | PM68 |
| NA | 3 | 11 | 367561.9 | 487 |
| MG | 4 | 12 | 545962.1 | 487 |
| AL | 5 | 13 | 755250. | 487 |
| SI | 6 | 14 | (995700.) | 374 |
| P | 7 | 15 | *1266000.* | 487 |
| S | 8 | 16 | 1569290. | 487 |
| CL | 9 | 17 | 1901850. | 487 |
| AR | 10 | 18 | (2266000.) | 374 |
| K | 11 | 19 | (2661000.) | 374 |
| CA | 12 | 20 | (3086000.) | 374 |
| SC | 13 | 21 | (3543000.) | 374 |
| TI | 14 | 22 | (4030000.) | 374 |
| V | 15 | 23 | (4548000.) | 374 |
| CR | 16 | 24 | (5092000.) | 374 |
| MN | 17 | 25 | (5665000.) | 374 |
| FE | 18 | 26 | (6271000.) | 374 |
| CO | 19 | 27 | (6910000.) | 374 |
| NI | 20 | 28 | (7580000.) | 374 |
| CU | 21 | 29 | (8270000.) | 374 |
| ZN | 22 | 30 | (9000000.) | 374 |

1S2 2S2 2P4( 3P ) 3S 4P 2

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 102680.44 | 420 |
| NE | 2 | 10 | 219650.76 | PM68 |
| NA | 3 | 11 | 367052.3 | 487 |
| MG | 4 | 12 | 545143.5 | 487 |
| AL | 5 | 13 | 753960. | 487 |
| SI | 6 | 14 | 993640. | 487 |
| P | 7 | 15 | 1264170. | 487 |
| S | 8 | 16 | 1565250. | 487 |
| CL | 9 | 17 | 1896600. | 487 |
| AR | 10 | 18 | 2259400. | 255 |
| K | 11 | 19 | *2652800.* | 487 |
| CA | 12 | 20 | 3077100. | 487 |
| SC | 13 | 21 | 3531000. | 143 |
| TI | 14 | 22 | 4014000. | 143 |
| V | 15 | 23 | 4527000. | 143 |
| CR | 16 | 24 | 5071000. | 143 |
| MN | 17 | 25 | 5643000. | 143 |
| FE | 18 | 26 | 6246000. | 143 |
| CO | 19 | 27 | 6882000. | 143 |
| NI | 20 | 28 | 7553000. | 143 |
| CU | 21 | 29 | 8244000. | 143 |
| ZN | 22 | 30 | (8972000.) | 374 |

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4( 3P ) 3S 4P 3

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 102405.71 | 420 |
| NE | 2 | 10 | 219133.10 | PM68 |
| NA | 3 | 11 | 366165.3 | 487 |
| MG | 4 | 12 | 543727.0 | 487 |
| AL | 5 | 13 | 751810. | 487 |
| SI | 6 | 14 | 990460. | 487 |
| P | 7 | 15 | 1259730. | 487 |
| S | 8 | 16 | 1559580. | 487 |
| CL | 9 | 17 | 1888970. | 487 |
| AR | 10 | 18 | 2247700. | 255 |
| K | 11 | 19 | *2640600.* | 487 |
| CA | 12 | 20 | 3062300. | 487 |
| SC | 13 | 21 | 3515000. | 143 |
| TI | 14 | 22 | 3995000. | 143 |
| V | 15 | 23 | 4504000. | 143 |
| CR | 16 | 24 | 5045000. | 143 |
| MN | 17 | 25 | 5617000. | 143 |
| FE | 18 | 26 | 6215000. | 143 |
| CO | 19 | 27 | 6854000. | 143 |
| NI | 20 | 28 | 7519000. | 143 |
| CU | 21 | 29 | 8210000. | 143 |
| ZN | 22 | 30 | (8937000.) | 374 |

1S2 2S2 2P4( 3P ) 3S 2P 1

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 105056.28 | 420 |
| NE | 2 | 10 | 224701.57 | PM68 |
| NA | 3 | 11 | 374681.4 | 487 |
| MG | 4 | 12 | 555338. | 487 |
| AL | 5 | 13 | 766790. | 487 |
| SI | 6 | 14 | 1009140. | 487 |
| P | 7 | 15 | 1282550. | 487 |
| S | 8 | 16 | 1586650. | 487 |
| CL | 9 | 17 | 1921050. | 487 |
| AR | 10 | 18 | 2287300. | 255 |
| K | 11 | 19 | (2685000.) | 374 |
| CA | 12 | 20 | (3114000.) | 374 |
| SC | 13 | 21 | 3575000. | 143 |
| TI | 14 | 22 | (4066000.) | 374 |
| V | 15 | 23 | (4589000.) | 374 |
| CR | 16 | 24 | *5139000.* | 143 |
| MN | 17 | 25 | (5730000.) | 374 |
| FE | 18 | 26 | (6346000.) | 375 |
| CO | 19 | 27 | (6995000.) | 374 |
| NI | 20 | 28 | (7675000.) | 374 |
| CU | 21 | 29 | (8386000.) | 374 |
| ZN | 22 | 30 | (9128000.) | 374 |

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4( 3P ) 3S 2P 2

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 104731.05 | 420 |
| NE | 2 | 10 | 224089.34 | PM68 |
| NA | 3 | 11 | 373633.0 | 487 |
| MG | 4 | 12 | 553659. | 487 |
| AL | 5 | 13 | 764240. | 487 |
| SI | 6 | 14 | 1005440. | 487 |
| P | 7 | 15 | 1277380. | 487 |
| S | 8 | 16 | 1579700. | 487 |
| CL | 9 | 17 | 1911950. | 487 |
| AR | 10 | 18 | 2276300. | 255 |
| K | 11 | 19 | *2671300.* | 487 |
| CA | 12 | 20 | 3097900. | 487 |
| SC | 13 | 21 | 3555000. | 143 |
| TI | 14 | 22 | 4044000. | 143 |
| V | 15 | 23 | 4562000. | 143 |
| CR | 16 | 24 | 5115000. | 143 |
| MN | 17 | 25 | 5685000. | 267 |
| FE | 18 | 26 | 6297000. | 143 |
| CO | 19 | 27 | 6935000. | 143 |
| NI | 20 | 28 | 7610000. | 143 |
| CU | 21 | 29 | (8307000.) | 374 |
| ZN | 22 | 30 | (9036000.) | 374 |

1S2 2S2 2P4( 3P ) 3P 4S* 2

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 118427.82 | 420 |
| NE | 2 | 10 | 252955.87 | PM68 |
| NA | 3 | 11 | 417415.5 | 487 |
| MG | 4 | 12 | 612240.3 | 487 |
| AL | 5 | 13 | (837100.) | 374 |
| SI | 6 | 14 | (1092000.) | 374 |
| P | 7 | 15 | (1377000.) | 374 |

1S2 2S2 2P4( 3P ) 3P 2S* 1

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 118405.27 | 420 |
| NE | 2 | 10 | 252800.79 | PM68 |
| NA | 3 | 11 | 416910.2 | 487 |
| MG | 4 | 12 | (610700.) | 374 |
| AL | 5 | 13 | (834300.) | 374 |
| SI | 6 | 14 | (1088000.) | 374 |
| P | 7 | 15 | (1370000.) | 374 |

1S2 2S2 2P4( 1D ) 3D 2S 1

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | (149000.) | 374 |
| NE | 2 | 10 | 306013.36 | PM68 |
| NA | 3 | 11 | 497751.2 | 487 |
| MG | 4 | 12 | 714330. | 487 |
| AL | 5 | 13 | 960860. | 487 |
| SI | 6 | 14 | 1241060. | 487 |
| P | 7 | 15 | 1555560. | 487 |
| S | 8 | 16 | 1894330. | 487 |
| CL | 9 | 17 | (2265000.) | 374 |
| AR | 10 | 18 | 2660030. | 259 |
| K | 11 | 19 | (3099000.) | 374 |
| CA | 12 | 20 | (3563000.) | 374 |
| SC | 13 | 21 | 4056000. | 143 |
| TI | 14 | 22 | *4531000.* | 143 |
| V | 15 | 23 | *5136000.* | 143 |
| CR | 16 | 24 | *5745000.* | 143 |
| MN | 17 | 25 | *6340000.* | 143 |
| FE | 18 | 26 | *6974000.* | 143 |

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4( 3P ) 3D 4P 1

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 128338.72 | 420 |
| NE | 2 | 10 | 280770.84 | PM68 |
| NA | 3 | 11 | 462391.2 | 487 |
| MG | 4 | 12 | (677000.) | 374 |
| AL | 5 | 13 | 921440. | 487 |
| SI | 6 | 14 | 1194970. | 487 |
| P | 7 | 15 | (1501000.) | 374 |
| S | 8 | 16 | 1835000. | 487 |
| CL | 9 | 17 | (2200000.) | 374 |
| AR | 10 | 18 | (2598000.) | 374 |

1S2 2S2 2P4( 3P ) 3D 4P 2

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 128523.28 | 420 |
| NE | 2 | 10 | 280991.85 | PM68 |
| NA | 3 | 11 | 462963.6 | 487 |
| MG | 4 | 12 | 677805. | 487 |
| AL | 5 | 13 | 922120. | 487 |
| SI | 6 | 14 | 1196040. | 487 |
| P | 7 | 15 | 1500040. | 487 |
| S | 8 | 16 | 1834830. | 487 |
| CL | 9 | 17 | (2200000.) | 374 |
| AR | 10 | 18 | (2598000.) | 374 |

1S2 2S2 2P4( 3P ) 3D 4P 3

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 128606.09 | 420 |
| NE | 2 | 10 | 281173.72 | PM68 |
| NA | 3 | 11 | 463257.4 | 487 |
| MG | 4 | 12 | 676837. | 487 |
| AL | 5 | 13 | 922640. | 487 |
| SI | 6 | 14 | 1197230. | 487 |
| P | 7 | 15 | 1496890. | 487 |
| S | 8 | 16 | 1838740. | 487 |
| CL | 9 | 17 | (2217000.) | 374 |
| AR | 10 | 18 | (2642000.) | 374 |

1S2 2S2 2P4( 3P ) 3D 2P 1

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 128520.22 | 420 |
| NE | 2 | 10 | 281334.87 | PM68 |
| NA | 3 | 11 | 465988.0 | 487 |
| MG | 4 | 12 | 681024. | 487 |
| AL | 5 | 13 | 925900. | 487 |
| SI | 6 | 14 | 1200720. | 487 |
| P | 7 | 15 | 1505300. | 487 |
| S | 8 | 16 | 1839250. | 487 |
| CL | 9 | 17 | (2205000.) | 374 |
| AR | 10 | 18 | (2601000.) | 374 |
| K | 11 | 19 | (3027000.) | 374 |
| CA | 12 | 20 | (3484000.) | 374 |
| SC | 13 | 21 | 3970000. | 143 |
| TI | 14 | 22 | 4488000. | 143 |
| V | 15 | 23 | 5042000. | 143 |
| CR | 16 | 24 | 5619000. | 143 |
| MN | 17 | 25 | 6229000. | 143 |
| FE | 18 | 26 | *6870000.* | 143 |
| CO | 19 | 27 | (7510000.) | 374 |
| NI | 20 | 28 | *8297000.* | 143 |

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4( 3P ) 3D 2P 2

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 128712.30 | 420 |
| NE | 2 | 10 | 281722.62 | PM68 |
| NA | 3 | 11 | 466773.0 | 487 |
| MG | 4 | 12 | 682471. | 487 |
| AL | 5 | 13 | 928410. | 487 |
| SI | 6 | 14 | 1204740. | 487 |
| P | 7 | 15 | 1511310. | 487 |
| S | 8 | 16 | 1847550. | 487 |
| CL | 9 | 17 | (2212000.) | 374 |
| AR | 10 | 18 | (2609000.) | 374 |
| K | 11 | 19 | (3037000.) | 374 |
| CA | 12 | 20 | (3495000.) | 374 |
| SC | 13 | 21 | 3981000. | 143 |
| TI | 14 | 22 | 4503000. | 143 |
| V | 15 | 23 | 5055000. | 143 |
| CR | 16 | 24 | 5636000. | 143 |
| MN | 17 | 25 | *6257000.* | 143 |
| FE | 18 | 26 | 6908000. | 143 |
| CO | 19 | 27 | 7556000. | 143 |
| NI | 20 | 28 | 8274000. | 143 |
| CU | 21 | 29 | 9011000. | 143 |

1S2 2S2 2P4( 1D ) 3D 2P 1

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 150000. | 374 |
| NE | 2 | 10 | 305584.57 | PM68 |
| NA | 3 | 11 | 493191.3 | 487 |
| MG | 4 | 12 | 711622. | 487 |
| AL | 5 | 13 | 960420. | 487 |
| SI | 6 | 14 | 1239200. | 487 |
| P | 7 | 15 | 1548480. | 487 |
| S | 8 | 16 | 1888460. | 487 |
| CL | 9 | 17 | (2257000.) | 374 |
| AR | 10 | 18 | (2659000.) | 374 |
| K | 11 | 19 | (3093000.) | 374 |
| CA | 12 | 20 | (3558000.) | 374 |
| SC | 13 | 21 | 4057000. | 143 |
| TI | 14 | 22 | 4583000. | 143 |
| V | 15 | 23 | 5141000. | 143 |
| CR | 16 | 24 | 5727000. | 143 |
| MN | 17 | 25 | 6353000. | 143 |
| FE | 18 | 26 | 7013000. | 143 |
| CO | 19 | 27 | 7698000. | 143 |
| NI | 20 | 28 | 8396000. | 143 |
| CU | 21 | 29 | (9142000.) | 374 |
| ZN | 22 | 30 | (9911000.) | 374 |

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4( 1D ) 3D 2P 2

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | (150000.) | 374 |
| NE | 2 | 10 | 305569.23 | PM68 |
| NA | 3 | 11 | 493289.3 | 487 |
| MG | 4 | 12 | 711865. | 487 |
| AL | 5 | 13 | 961630. | 487 |
| SI | 6 | 14 | 1242390. | 487 |
| P | 7 | 15 | 1552170. | 487 |
| S | 8 | 16 | 1897460. | 487 |
| CL | 9 | 17 | (2267000.) | 374 |
| AR | 10 | 18 | (2671000.) | 374 |
| K | 11 | 19 | (3107000.) | 374 |
| CA | 12 | 20 | (3573000.) | 374 |
| SC | 13 | 21 | 4072000. | 143 |
| TI | 14 | 22 | 4602000. | 143 |
| V | 15 | 23 | 5160000. | 143 |
| CR | 16 | 24 | 5754000. | 143 |
| MN | 17 | 25 | 6382000. | 143 |
| FE | 18 | 26 | 7042000. | 143 |
| CO | 19 | 27 | 7728000. | 143 |
| NI | 20 | 28 | 8446000. | 143 |
| CU | 21 | 29 | (9200000.) | 374 |
| ZN | 22 | 30 | (9984000.) | 374 |

1S2 2S2 2P4( 3P ) 3D 4D 1

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 128184.99 | 420 |
| NE | 2 | 10 | 279425.22 | PM68 |
| NA | 3 | 11 | 460759.3 | 487 |
| MG | 4 | 12 | 677365.3 | 710 |
| AL | 5 | 13 | 920680. | 487 |
| SI | 6 | 14 | (1192000.) | 374 |
| P | 7 | 15 | (1496000.) | 374 |
| S | 8 | 16 | 1822510. | 487 |
| CL | 9 | 17 | (2196000.) | 374 |
| AR | 10 | 18 | (2591000.) | 374 |
| K | 11 | 19 | (3020000.) | 374 |
| CA | 12 | 20 | (3500000.) | 374 |

1S2 2S2 2P4( 3P ) 3D 4D 2

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 128122.72 | 420 |
| NE | 2 | 10 | 279327.24 | PM68 |
| NA | 3 | 11 | 460605.6 | 487 |
| MG | 4 | 12 | 677365.3 | 710 |
| AL | 5 | 13 | 920680. | 487 |
| SI | 6 | 14 | (1192000.) | 374 |
| P | 7 | 15 | (1496000.) | 374 |
| S | 8 | 16 | 1822510. | 487 |
| CL | 9 | 17 | (2196000.) | 374 |
| AR | 10 | 18 | (2591000.) | 374 |
| K | 11 | 19 | (3020000.) | 374 |
| CA | 12 | 20 | (3500000.) | 374 |
| SC | 13 | 21 | 3964000. | 143 |
| TI | 14 | 22 | 4480000. | 143 |
| V | 15 | 23 | 5023000. | 143 |
| CR | 16 | 24 | 5599000. | 143 |
| MN | 17 | 25 | 6207000. | 143 |
| FE | 18 | 26 | 6849000. | 143 |
| CO | 19 | 27 | (7520000.) | 374 |
| NI | 20 | 28 | 8224000. | 143 |
| CU | 21 | 29 | 8955000. | 143 |

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4( 3P ) 3D 4D 3

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 128087.83 | 420 |
| NE | 2 | 10 | 279221.00 | PM68 |
| NA | 3 | 11 | 460421.0 | 487 |
| MG | 4 | 12 | 676827.8 | 710 |
| AL | 5 | 13 | 919900. | 487 |
| SI | 6 | 14 | (1192000.) | 374 |
| P | 7 | 15 | (1496000.) | 374 |
| S | 8 | 16 | 1831370. | 487 |
| CL | 9 | 17 | (2196000.) | 374 |
| AR | 10 | 18 | (2591000.) | 374 |
| K | 11 | 19 | (3020000.) | 374 |
| CA | 12 | 20 | (3500000.) | 374 |

1S2 2S2 2P4( 3P ) 3D 4D 4

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 128064.10 | 420 |
| NE | 2 | 10 | 279139.96 | PM68 |
| NA | 3 | 11 | 460267.8 | 487 |
| MG | 4 | 12 | 676827.8 | 710 |
| AL | 5 | 13 | 919900. | 487 |
| SI | 6 | 14 | (1192000.) | 374 |
| P | 7 | 15 | (1496000.) | 374 |
| S | 8 | 16 | 1831370. | 487 |
| CL | 9 | 17 | (2196000.) | 374 |
| AR | 10 | 18 | (2591000.) | 374 |
| K | 11 | 19 | (3020000.) | 374 |
| CA | 12 | 20 | (3500000.) | 374 |

1S2 2S2 2P4( 3P ) 3D 2D 2

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 128219.83 | 420 |
| NE | 2 | 10 | 280475.90 | PM68 |
| NA | 3 | 11 | 465027.9 | 487 |
| MG | 4 | 12 | 680030. | 487 |
| AL | 5 | 13 | 925430. | 487 |
| SI | 6 | 14 | 1201100. | 487 |
| P | 7 | 15 | 1506730. | 487 |
| S | 8 | 16 | 1842770. | 487 |
| CL | 9 | 17 | (2210000.) | 374 |
| AR | 10 | 18 | (2615000.) | 374 |
| K | 11 | 19 | (3040000.) | 374 |
| CA | 12 | 20 | (3500000.) | 374 |
| SC | 13 | 21 | 3987000. | 143 |
| TI | 14 | 22 | *4558200.* | 143 |
| V | 15 | 23 | *5066000.* | 143 |
| CR | 16 | 24 | 5653000. | 143 |
| MN | 17 | 25 | *6231000.* | 143 |
| FE | 18 | 26 | *6916000.* | 208 |
| CO | 19 | 27 | 7587000. | 143 |

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4( 3P ) 3D 2D 3

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | 128140.48 | 420 |
| NE | 2 | 10 | 280271.29 | PM68 |
| NA | 3 | 11 | 464392.1 | 487 |
| MG | 4 | 12 | 678403. | 487 |
| AL | 5 | 13 | 926400. | 487 |
| SI | 6 | 14 | 1202960. | 487 |
| P | 7 | 15 | 1502040. | 487 |
| S | 8 | 16 | 1847810. | 487 |
| CL | 9 | 17 | (2210000.) | 374 |
| AR | 10 | 18 | 2616430. | 259 |
| K | 11 | 19 | (3040000.) | 374 |
| CA | 12 | 20 | (3500000.) | 374 |
| SC | 13 | 21 | 4005000. | 143 |
| TI | 14 | 22 | 4531000. | 143 |
| V | 15 | 23 | 5087000. | 143 |
| CR | 16 | 24 | 5675000. | 143 |
| MN | 17 | 25 | 6297000. | 143 |
| FE | 18 | 26 | 6959000. | 143 |
| CO | 19 | 27 | 7639000. | 143 |
| NI | 20 | 28 | 8354000. | 143 |
| CU | 21 | 29 | 9099000. | 143 |

1S2 2S2 2P4( 1D ) 3D 2D 2

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | (160000.) | 374 |
| NE | 2 | 10 | 306265.06 | PM68 |
| NA | 3 | 11 | 493853.2 | 487 |
| MG | 4 | 12 | 712120. | 487 |
| AL | 5 | 13 | 963330. | 487 |
| SI | 6 | 14 | 1243860. | 487 |
| P | 7 | 15 | 1554420. | 487 |
| S | 8 | 16 | 1898220. | 487 |
| CL | 9 | 17 | (2275000.) | 374 |
| AR | 10 | 18 | 2672370. | 259 |
| K | 11 | 19 | (3105000.) | 374 |
| CA | 12 | 20 | (3560000.) | 374 |

1S2 2S2 2P4( 1D ) 3D 2D 3

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | (160000.) | 374 |
| NE | 2 | 10 | 306245.71 | PM68 |
| NA | 3 | 11 | 494599.0 | 487 |
| MG | 4 | 12 | 713389. | 487 |
| AL | 5 | 13 | 962640. | 487 |
| SI | 6 | 14 | 1242220. | 487 |
| P | 7 | 15 | 1553740. | 487 |
| S | 8 | 16 | 1892000. | 487 |
| CL | 9 | 17 | (2275000.) | 374 |
| AR | 10 | 18 | 2672370. | 259 |
| K | 11 | 19 | (3105000.) | 374 |
| CA | 12 | 20 | (3560000.) | 374 |
| SC | 13 | 21 | 4047000. | 143 |
| TI | 14 | 22 | 4568000. | 143 |
| V | 15 | 23 | 5120000. | 143 |
| CR | 16 | 24 | 5701000. | 143 |
| MN | 17 | 25 | 6317000. | 143 |
| FE | 18 | 26 | 6935000. | 208 |
| CO | 19 | 27 | 7616000. | 143 |
| NI | 20 | 28 | 8292000. | 143 |
| CU | 21 | 29 | 9025000. | 143 |

TABLE XV FLUORINE ISOELECTRONIC SEQUENCE (cont.)

1S2 2S2 2P4( 1S ) 3D 2D 2

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | (171000.) | 374 |
| NE | 2 | 10 | (335000.) | 374 |
| NA | 3 | 11 | 529498. | 487 |
| MG | 4 | 12 | 752965. | 487 |
| AL | 5 | 13 | 1007290. | 487 |
| SI | 6 | 14 | 1291800. | 487 |
| P | 7 | 15 | 1606880. | 487 |
| S | 8 | 16 | 1953010. | 487 |
| CL | 9 | 17 | 2330130. | 487 |
| AR | 10 | 18 | (2739000.) | 374 |
| K | 11 | 19 | (3179000.) | 374 |
| CA | 12 | 20 | 3652400. | 487 |
| SC | 13 | 21 | 4157000. | 143 |
| TI | 14 | 22 | 4688000. | 143 |
| V | 15 | 23 | 5264000. | 143 |
| CR | 16 | 24 | 5860000. | 143 |
| MN | 17 | 25 | *6507000.* | 143 |
| FE | 18 | 26 | *7173000.* | 143 |
| CO | 19 | 27 | *7889000.* | 143 |
| NI | 20 | 28 | *8607000.* | 143 |
| CU | 21 | 29 | *9364000.* | 143 |
| ZN | 22 | 30 | (10140000.) | 374 |

1S2 2S2 2P4( 1S ) 3D 2D 3

| | | | | |
|---|---|---|---|---|
| F | 1 | 9 | (171000.) | 374 |
| NE | 2 | 10 | (335000.) | 374 |
| NA | 3 | 11 | 529465. | 487 |
| MG | 4 | 12 | 752927. | 487 |
| AL | 5 | 13 | 1007150. | 487 |
| SI | 6 | 14 | 1291510. | 487 |
| P | 7 | 15 | 1606550. | 487 |
| S | 8 | 16 | 1952100. | 487 |
| CL | 9 | 17 | 2328830. | 487 |
| AR | 10 | 18 | (2737000.) | 374 |
| K | 11 | 19 | (3177000.) | 374 |
| CA | 12 | 20 | 3648000. | 487 |
| SC | 13 | 21 | 4151000. | 143 |
| TI | 14 | 22 | 4684000. | 143 |
| V | 15 | 23 | 5252000. | 143 |
| CR | 16 | 24 | 5851000. | 143 |
| MN | 17 | 25 | 6494000. | 143 |
| FE | 18 | 26 | 7128000. | 143 |
| CO | 19 | 27 | 7834000. | 143 |
| NI | 20 | 28 | 8554000. | 143 |
| CU | 21 | 29 | 9311000. | 143 |
| ZN | 22 | 30 | (10090000.) | 374 |

TABLE XVI

TRANSITIONS - FLUORINE ISOELECTRONIC SEQUENCE

| | | F I | Ne II | Na III | Mg IV | Al V | Si VI | P VII | S VIII |
|---|---|---|---|---|---|---|---|---|---|
| $2p^5 - 2s2p^6$ | $^2P^0_{3/2} - {}^2S_{1/2}$ | 588.84 | 460.72 | 378.14 | 321.00 | 278.70 | 246.00 | 219.91 | 198.55 |
| $2p^5 - 2p^4(^1S)3s$ | $^2P^0_{3/2} - {}^2S_{1/2}$ | 671.21 | 361.43 | 229.87 | 160.23 | 118.50 | 91.37 | 72.68 | 59.24 |
| $2p^5 - 2p^4(^1S)3d$ | $^2P^0_{3/2} - {}^2D_{5/2}$ | (584.79) | (298.51) | 188.87 | 132.82 | 99.29 | 77.43 | 62.24 | 51.23 |
| $2p^5 - 2p^4(^3P)3s$ | $^2P^0_{3/2} - {}^2P_{3/2}$ | 954.83 | 446.25 | 267.64 | 180.62 | 130.85 | 99.46 | 78.29 | 63.30 |
| $2p^5 - 2p^4(^3P)3d$ | $^2P^0_{3/2} - {}^2P_{3/2}$ | 776.93 | 354.96 | 214.24 | 146.53 | 107.71 | 83.00 | 66.17 | 54.13 |
| | $^2P^0_{3/2} - {}^2D_{5/2}$ | 780.39 | 356.80 | 215.33 | 147.40 | 107.94 | 83.12 | 66.57 | 54.12 |
| $2p^5 - 2p^4(^1D)3d$ | $^2P^0_{3/2} - {}^2S_{1/2}$ | (671.14) | 326.78 | 200.90 | 139.99 | 104.07 | 80.57 | 64.29 | 52.79 |
| | $^2P^0_{3/2} - {}^2P_{3/2}$ | (666.67) | 327.26 | 202.72 | 140.48 | 103.99 | 80.49 | 64.43 | 52.70 |
| | $^2P^0_{3/2} - {}^2D_{5/2}$ | (625.00) | 326.53 | 202.18 | 140.18 | 103.88 | 80.50 | 64.36 | 52.85 |
| $2p^4(^3P)3s - 2p^4(^3P)3p$ | $^4P_{5/2} - {}^4S^0_{3/2}$ | 6241.38 | 2956.59 | 1951.21 | 1459.57 | (1172.47) | (984.83) | (852.73) | |
| $2p^4(^3P)3p - 2p^4(^3P)3d$ | $^4S^0_{3/2} - {}^4P_{5/2}$ | 9824.85 | 3543.86 | 2181.41 | 1548.07 | (1169.04) | (950.30) | (834.10) | |
| | $^4S^0_{3/2} - {}^4D_{5/2}$ | 10351.95 | 3807.33 | 2325.28 | 1548.29 | (1207.73) | (1000.00) | (840.34) | |

Note: Transitions in Angstroms. ( ) indicates prediction.

TABLE XVI

TRANSITIONS - FLUORINE ISOELECTRONIC SEQUENCE (continued)

| | | Cl IX | Ar X | K XI | Ca XII | Sc XIII | Ti XIV | V XV |
|---|---|---|---|---|---|---|---|---|
| $2p^5 - 2s2p^6$ | $^2P^0_{3/2} - {}^2S_{1/2}$ | 180.70 | 165.57 | 152.45 | 141.05 | 130.96 | 122.01 | (113.99) |
| $2p^5 - 2p^4(^1S)3s$ | $^2P^0_{3/2} - {}^2S_{1/2}$ | 49.23 | 41.56 | (35.78) | (31.06) | (27.23) | | |
| $2p^5 - 2p^4(^1S)3d$ | $^2P^0_{3/2} - {}^2D_{5/2}$ | 42.94 | (36.54) | (31.48) | 27.41 | 24.09 | 21.35 | 19.04 |
| $2p^5 - 2p^4(^3P)3s$ | $^2P^0_{3/2} - {}^2P_{3/2}$ | 52.30 | 43.93 | 37.44 | 32.28 | 28.13 | 24.73 | 21.92 |
| $2p^5 - 2p^4(^3P)3d$ | $^2P^0_{3/2} - {}^2P_{3/2}$ | (45.21) | (38.32) | (32.93) | (28.61) | 25.12 | 22.21 | 19.78 |
| | $^2P^0_{3/2} - {}^2D_{5/2}$ | (45.25) | 38.22 | (32.89) | (28.57) | 24.97 | 22.07 | 19.66 |
| $2p^5 - 2p^4(^1D)3d$ | $^2P^0_{3/2} - {}^2S_{1/2}$ | (44.15) | 37.59 | (32.27) | (28.07) | 24.65 | 22.07 | 19.47 |
| | $^2P^0_{3/2} - {}^2P_{3/2}$ | (44.11) | 37.44 | (32.19) | (27.99) | 24.56 | 21.73 | 19.38 |
| | $^2P^0_{3/2} - {}^2D_{5/2}$ | (43.95) | 37.42 | (32.21) | (28.09) | 24.71 | 21.89 | 19.53 |
| $2p^4(^3P)3s - 2p^4(^3P)3p$ | $^4P_{5/2} - {}^4S^0_{3/2}$ | | | | | | | |
| $2p^4(^3P)3p - 2p^4(^3P)3d$ | $^4S^0_{3/2} - {}^4P_{5/2}$ | | | | | | | |
| | $^4S^0_{3/2} - {}^4D_{5/2}$ | | | | | | | |

TABLE XVI

TRANSITIONS - FLUORINE ISOELECTRONIC SEQUENCE (continued)

| | | Cr XVI | Mn XVII | FE XVIII | Co XIX | Ni XX | Cu XXI | Zn XXII |
|---|---|---|---|---|---|---|---|---|
| $2p^5 - 2s2p^6$ | $^2P^0_{3/2} - {}^2S_{1/2}$ | (106.76) | (100.20) | (94.25) | (88.81) | (83.68) | (79.05) | (74.79) |
| $2p^5 - 2p^4(^1S)3s$ | $^2P^0_{3/2} - {}^2S_{1/2}$ | | | | | | | |
| $2p^5 - 2p^4(^1S)3d$ | $^2P^0_{3/2} - {}^2D_{5/2}$ | 17.09 | 15.40 | 14.03 | 12.76 | 11.69 | 10.74 | (9.91) |
| $2p^5 - 2p^4(^3P)3s$ | $^2P^0_{3/2} - {}^2P_{3/2}$ | 19.55 | 17.59 | 15.88 | 14.42 | 13.14 | (12.04) | (11.07) |
| $2p^5 - 2p^4(^3P)3d$ | $^2P^0_{3/2} - {}^2P_{3/2}$ | 17.74 | 15.98 | 14.48 | 13.23 | 12.09 | 11.10 | |
| | $^2P^0_{3/2} - {}^2D_{5/2}$ | 17.62 | 15.88 | 14.37 | 13.09 | 11.97 | 10.99 | |
| $2p^5 -2p^4(^1D)3d$ | $^2P^0_{3/2} - {}^2S_{1/2}$ | 17.41 | 15.77 | 14.34 | | | | |
| | $^2P^0_{3/2} - {}^2P_{3/2}$ | 17.38 | 15.67 | 14.20 | 12.94 | 11.84 | (10.87) | (10.02) |
| | $^2P^0_{3/2} - {}^2D_{5/2}$ | 17.54 | 15.83 | 14.42 | 13.13 | 12.06 | 11.08 | |
| $2p^4(^3P)3s - 2p^4(^3P)3p$ | $^4P_{5/2} - {}^4S^0_{3/2}$ | | | | | | | |
| $2p^4(^3P)3p - 2p^4(^3P)3d$ | $^4S^0_{3/2} - {}^4P_{5/2}$ | | | | | | | |
| | $^4S^0_{3/2} - {}^4D_{5/2}$ | | | | | | | |

TABLE XVII NEON ISOELECTRONIC SEQUENCE

1S2 2S 2P6( ) 3P 3P* 1

| | | | | |
|---|---|---|---|---|
| AL | 4 | 13 | (1074000.) | 374 |
| SI | 5 | 14 | (1351000.) | 374 |
| P | 6 | 15 | (1660000.) | 374 |
| S | 7 | 16 | 2000400. | 487 |
| CL | 8 | 17 | *2371580.* | 487 |
| AR | 9 | 18 | (2782000.) | 374 |
| K | 10 | 19 | 3219400. | 487 |
| CA | 11 | 20 | 3692900. | 487 |
| SC | 12 | 21 | 4198000. | 232 |
| TI | 13 | 22 | 4733000. | 265 |
| TI | 13 | 22 | 4733300. | 232 |
| V | 14 | 23 | 5299400. | 232 |
| CR | 15 | 24 | 5894500. | 487 |
| MN | 16 | 25 | 6530800. | 487 |
| FE | 17 | 26 | 7201000. | 487 |
| CO | 18 | 27 | 7898300. | 487 |
| NI | 19 | 28 | 8628000. | 264 |
| CU | 20 | 29 | 9390000. | 264 |
| ZN | 21 | 30 | (10190000.) | 374 |

1S2 2S 2P6( ) 3P 1P* 1

| | | | | |
|---|---|---|---|---|
| AL | 4 | 13 | (1075000.) | 374 |
| SI | 5 | 14 | (1352000.) | 374 |
| P | 6 | 15 | (1662000.) | 374 |
| S | 7 | 16 | 2000400. | 487 |
| CL | 8 | 17 | *2401770.* | 487 |
| AR | 9 | 18 | 2791740. | 259 |
| K | 10 | 19 | 3237600. | 487 |
| CA | 11 | 20 | 3708900. | 487 |
| SC | 12 | 21 | 4215400. | 232 |
| TI | 13 | 22 | 4752000. | 232 |
| TI | 13 | 22 | 4753000. | 265 |
| V | 14 | 23 | 5324200. | 232 |
| CR | 15 | 24 | 5921000. | 487 |
| MN | 16 | 25 | 6562500. | 487 |
| FE | 17 | 26 | 7235900. | 487 |
| CO | 18 | 27 | 7937100. | 487 |
| NI | 19 | 28 | 8673000. | 264 |
| CU | 20 | 29 | 9434000. | 264 |
| ZN | 21 | 30 | 10235000. | 264 |

TABLE XVIII

TRANSITIONS - NEON ISOELECTRONIC SEQUENCE

| Transition | | Ne I | Na II | Mg III | Al IV | Si V | P VI | S VII | Cl VIII | Ar IX | K X |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $2s^2 2p^6 - 2s 2p^6 3p$ | $^1S_0 - {}^1P_1^o$ | | | | (93.02) | (73.96) | (60.17) | 49.99 | 41.63 | 35.82 | 30.89 |
| | $^1S_0 - {}^3P_1^o$ | | | | (93.11) | (74.02) | (60.24) | 49.99 | 42.17 | (35.94) | 31.06 |

| Transition | | Ca XI | Sc XII | Ti XIII | V XIV | Cr XV | Mn XVI | Fe XVII | Co XVIII | Ni XIX | Cu XX | Zn XXI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $2s^2 2p^6 - 2s 2p^6 3p$ | $^1S_0 - {}^1P_1^o$ | 26.96 | 23.72 | 21.04 | 18.78 | 16.89 | 15.24 | 13.82 | 12.60 | 11.53 | 10.60 | 9.77 |
| | $^1S_0 - {}^3P_1^o$ | 27.07 | 23.82 | 21.13 | 18.87 | 16.96 | 15.31 | 13.89 | 12.66 | 11.59 | 10.65 | (9.81) |

Note: Transitions in Angstroms.

( ) indicates prediction.

$^1S_0 - {}^3P_1^o$ is an intercombination transition.

TABLE XIX SODIUM ISOELECTRONIC SEQUENCE

( ) 5S 2S 1

| | | | | |
|---|---|---|---|---|
| NA | 1 | 11 | 33200.696 | 487 |
| MG | 2 | 12 | 92790.51 | 592 |
| AL | 3 | 13 | 170637.35 | 826 |
| SI | 4 | 14 | 265417.95 | 504 |
| P | 5 | 15 | 376639.2 | 487 |
| S | 6 | 16 | 504112. | 487 |
| CL | 7 | 17 | 647677. | 487 |
| AR | 8 | 18 | 812422. | 487 |
| K | 9 | 19 | 979901. | 487 |
| CA | 10 | 20 | 1170098. | 487 |
| SC | 11 | 21 | 1382110. | 487 |
| TI | 12 | 22 | (1602000.) | 374 |
| V | 13 | 23 | (1841000.) | 374 |
| CR | 14 | 24 | (2097000.) | 374 |
| MN | 15 | 25 | (2371000.) | 374 |
| FE | 16 | 26 | 2662230. | 266 |
| CO | 17 | 27 | (2973000.) | 374 |
| NI | 18 | 28 | (3304000.) | 374 |

( ) 5P 2P* 1

| | | | | |
|---|---|---|---|---|
| NA | 1 | 11 | 35040.27 | 487 |
| MG | 2 | 12 | 97455.12 | 592 |
| AL | 3 | 13 | 178433.43 | 826 |
| SI | 4 | 14 | 276503.67 | 504 |
| P | 5 | 15 | 391101.7 | 487 |
| S | 6 | 16 | 522030. | 487 |
| CL | 7 | 17 | (668400.) | 374 |
| AR | 8 | 18 | 832245. | 487 |
| K | 9 | 19 | (1011000.) | 374 |
| CA | 10 | 20 | (1207000.) | 374 |
| SC | 11 | 21 | 1418280. | 487 |
| TI | 12 | 22 | 1645820. | 487 |
| V | 13 | 23 | 1889360. | 487 |
| CR | 14 | 24 | 2149290. | 178 |
| MN | 15 | 25 | (2425000.) | 374 |
| FE | 16 | 26 | (2718000.) | 374 |
| CO | 17 | 27 | (3026000.) | 374 |
| NI | 18 | 28 | (3350000.) | 374 |

( ) 5P 2P* 2

| | | | | |
|---|---|---|---|---|
| NA | 1 | 11 | 35042.79 | 487 |
| MG | 2 | 12 | 97468.92 | 592 |
| AL | 3 | 13 | 178470.32 | 826 |
| SI | 4 | 14 | 276579.03 | 504 |
| P | 5 | 15 | 391242.4 | 487 |
| S | 6 | 16 | 522248. | 487 |
| CL | 7 | 17 | (668800.) | 374 |
| AR | 8 | 18 | 832691. | 487 |
| K | 9 | 19 | (1012000.) | 374 |
| CA | 10 | 20 | (1208000.) | 374 |
| SC | 11 | 21 | 1419550. | 487 |
| TI | 12 | 22 | 1647310. | 487 |
| V | 13 | 23 | 1891430. | 487 |
| CR | 14 | 24 | 2152020. | 178 |
| MN | 15 | 25 | (2429000.) | 374 |
| FE | 16 | 26 | 2723310. | 266 |
| CO | 17 | 27 | (3031000.) | 374 |
| NI | 18 | 28 | 3355700. | 266 |

( ) 6S 2S 1

| | | | | |
|---|---|---|---|---|
| NA | 1 | 11 | 36372.647 | 487 |
| MG | 2 | 12 | 103196.75 | 592 |
| AL | 3 | 13 | 191484.23 | 826 |
| SI | 4 | 14 | 299676.95 | 504 |
| P | 5 | 15 | 427157. | 487 |
| S | 6 | 16 | 573823. | 487 |
| CL | 7 | 17 | (739700.) | 374 |
| AR | 8 | 18 | (924200.) | 374 |
| K | 9 | 19 | (1127000.) | 374 |
| CA | 10 | 20 | (1349000.) | 374 |
| SC | 11 | 21 | 1588790. | 487 |
| TI | 12 | 22 | (1848000.) | 374 |
| V | 13 | 23 | (2125000.) | 374 |
| CR | 14 | 24 | (2422000.) | 374 |
| MN | 15 | 25 | (2739000.) | 374 |
| FE | 16 | 26 | 3075170. | 266 |
| CO | 17 | 27 | (3432000.) | 374 |
| NI | 18 | 28 | (3811000.) | 374 |

( ) 6P 2P* 1

| | | | | |
|---|---|---|---|---|
| NA | 1 | 11 | 37296.51 | 487 |
| MG | 2 | 12 | 105622.34 | 592 |
| AL | 3 | 13 | 195621.72 | 826 |
| SI | 4 | 14 | 305641.10 | 504 |
| P | 5 | 15 | 435100.4 | 487 |
| S | 6 | 16 | 583679. | 487 |
| CL | 7 | 17 | (751700.) | 374 |
| AR | 8 | 18 | (938200.) | 374 |
| K | 9 | 19 | (1143000.) | 374 |
| CA | 10 | 20 | (1367000.) | 374 |
| SC | 11 | 21 | 1609480. | 017 |
| TI | 12 | 22 | (1871000.) | 374 |
| V | 13 | 23 | (2151000.) | 374 |
| CR | 14 | 24 | (2450000.) | 374 |
| MN | 15 | 25 | (2770000.) | 374 |
| FE | 16 | 26 | 3109450. | 266 |
| CO | 17 | 27 | (3470000.) | 374 |
| NI | 18 | 28 | (3853000.) | 374 |

( ) 6P 2P* 2

| | | | | |
|---|---|---|---|---|
| NA | 1 | 11 | 37297.76 | 487 |
| MG | 2 | 12 | 105629.72 | 592 |
| AL | 3 | 13 | 195641.74 | 826 |
| SI | 4 | 14 | 305682.27 | 504 |
| P | 5 | 15 | 435100.4 | 487 |
| S | 6 | 16 | 583679. | 487 |
| CL | 7 | 17 | (751700.) | 374 |
| AR | 8 | 18 | (938200.) | 374 |
| K | 9 | 19 | (1143000.) | 374 |
| CA | 10 | 20 | (1367000.) | 374 |
| SC | 11 | 21 | 1609480. | 017 |
| TI | 12 | 22 | (1871000.) | 374 |
| V | 13 | 23 | (2151000.) | 374 |
| CR | 14 | 24 | (2450000.) | 374 |
| MN | 15 | 25 | (2770000.) | 374 |
| FE | 16 | 26 | 3109450. | 266 |
| CO | 17 | 27 | (3470000.) | 374 |
| NI | 18 | 28 | (3853000.) | 374 |

2P5 3S2( ) 2P* 1

| | | | | |
|---|---|---|---|---|
| K | 9 | 19 | (2351000.) | 374 |
| CA | 10 | 20 | (2748000.) | 374 |
| SC | 11 | 21 | (3176000.) | 374 |
| TI | 12 | 22 | 3637900. | 265 |
| V | 13 | 23 | 4131900. | 265 |
| CR | 14 | 24 | 4658300. | 265 |
| MN | 15 | 25 | *5220600.* | 265 |
| FE | 16 | 26 | 5811900. | 265 |
| CO | 17 | 27 | 6430500. | 265 |
| NI | 18 | 28 | 7092000. | 265 |
| CU | 19 | 29 | (7780000.) | 374 |
| ZN | 20 | 30 | (8502000.) | 374 |

2P5 3S2( ) 2P* 2

| | | | | |
|---|---|---|---|---|
| K | 9 | 19 | (2328000.) | 374 |
| CA | 10 | 20 | (2720000.) | 374 |
| SC | 11 | 21 | (3142000.) | 374 |
| TI | 12 | 22 | 3594700. | 265 |
| V | 13 | 23 | 4078800. | 265 |
| CR | 14 | 24 | 4593500. | 265 |
| MN | 15 | 25 | *5141400.* | 265 |
| FE | 16 | 26 | 5717200. | 265 |
| CO | 17 | 27 | 6317900. | 265 |
| NI | 18 | 28 | 6959000. | 265 |
| CU | 19 | 29 | 7628000. | 265 |
| ZN | 20 | 30 | (8326000.) | 374 |

TABLE XX

TRANSITIONS - SODIUM ISOELECTRONIC SEQUENCE

| | | Na I | Mg II | Al III | Si IV | P V | S VI | Cl VII | Ar VIII | K IX | Ca X |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3p - 5s | $^2P^0_{1/2} - {}^2S_{1/2}$ | 6155.92 | 1750.66 | 855.04 | 515.12 | 347.24 | 251.11 | 190.59 | 148.73 | 121.54 | 100.41 |
| | $^2P^0_{3/2} - {}^2S_{1/2}$ | 6162.44 | 1753.47 | 856.75 | 516.34 | 348.20 | 251.90 | 191.28 | 149.33 | 122.10 | 100.93 |
| 3p - 6s | $^2P^0_{1/2} - {}^2S_{1/2}$ | 5150.27 | 1480.88 | 725.68 | 437.85 | 295.42 | 213.70 | (162.15) | (127.53) | (103.11) | (85.12) |
| | $^2P^0_{3/2} - {}^2S_{1/2}$ | 5154.83 | 1482.89 | 726.92 | 438.73 | 296.11 | 214.28 | (162.65) | (127.97) | (103.51) | (85.49) |
| 3s - 5p | $^2S_{1/2} - {}^2P^0_{1/2}$ | 2853.86 | 1026.11 | 560.43 | 361.66 | 255.69 | 191.56 | (149.61) | 120.16 | (98.91) | (82.85) |
| | $^2S_{1/2} - {}^2P^0_{3/2}$ | 2853.65 | 1025.97 | 560.32 | 361.56 | 255.60 | 191.48 | (149.52) | 120.09 | (98.81) | (82.78) |
| 3s - 6p | $^2S_{1/2} - {}^2P^0_{1/2}$ | 2681.22 | 946.77 | 511.19 | 327.18 | 229.83 | 171.33 | (133.03) | (106.59) | (87.49) | (73.15) |
| | $^2S_{1/2} - {}^2P^0_{3/2}$ | 2681.12 | 946.70 | 511.14 | 327.14 | 229.83 | 171.33 | (133.03) | (106.59) | (87.49) | (73.15) |
| $2p^6 3s - 2p^5 3s^2$ | $^2S_{1/2} - {}^2P^0_{1/2}$ | | | | | | | | | (42.54) | (36.39) |
| | $^2S_{1/2} - {}^2P^0_{3/2}$ | | | | | | | | | (42.96) | (36.76) |

Note: Transitions in Angstroms

( ) indicates prediction.

TABLE XX

TRANSITIONS - SODIUM ISOELECTRONIC SEQUENCE (continued)

| | | Sc XI | Ti XII | V XIII | Cr XIV | Mn XV | Fe XVI | Co XVII | Ni XVIII | Cu XIX | Zn XX |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3p - 5s | $^2P^0_{1/2} - {}^2S_{1/2}$ | 83.96 | (71.76) | (61.90) | (53.93) | (47.37) | 41.92 | (37.32) | (33.40) | | |
| | $^2P^0_{3/2} - {}^2S_{1/2}$ | 84.43 | (72.21) | (62.32) | (54.33) | (47.76) | 42.30 | (37.68) | (33.75) | | |
| 3p - 6s | $^2P^0_{1/2} - {}^2S_{1/2}$ | 71.54 | (60.99) | (52.64) | (45.89) | (40.34) | 35.74 | (31.86) | (28.56) | | |
| | $^2P^0_{3/2} - {}^2S_{1/2}$ | 71.89 | (61.31) | (52.95) | (46.18) | (40.62) | 36.01 | (32.12) | (28.82) | | |
| 3s - 5p | $^2S_{1/2} - {}^2P^0_{1/2}$ | 70.51 | 60.76 | 52.93 | 46.53 | (41.24) | (36.79) | (33.05) | (29.85) | | |
| | $^2S_{1/2} - {}^2P^0_{3/2}$ | 70.44 | 60.70 | 52.87 | 46.46 | (41.17) | 36.72 | (32.99) | 29.80 | | |
| 3s - 6p | $^2S_{1/2} - {}^2P^0_{1/2}$ | 62.13 | (53.45) | (46.49) | (40.82) | (36.10) | 32.16 | (28.82) | (25.95) | | |
| | $^2S_{1/2} - {}^2P^0_{3/2}$ | 62.13 | (53.45) | (46.49) | (40.82) | (36.10) | 32.16 | (28.82) | (25.95) | | |
| $2p^63s - 2p^53s^2$ | $^2S_{1/2} - {}^2P^0_{1/2}$ | (31.49) | 27.49 | 24.20 | 21.47 | 19.15 | 17.21 | 15.55 | 14.10 | (12.85) | (11.76) |
| | $^2S_{1/2} - {}^2P^0_{3/2}$ | (31.83) | 27.82 | 24.52 | 21.77 | 19.45 | 17.49 | 15.82 | 14.37 | 13.11 | (12.01) |

TABLE XXI

COMPARISON OF TRANSITIONS IN THE SI VI SPECTRUM

| | | | | |
|---|---|---|---|---|
| 2s2p - 2p3p | ${}^1P_1^0$ - ${}^1P_1$ | (46.66) | [46.62] | 46.67 |
| $2p^2$ - 2p3s | ${}^1S_0$ - ${}^1P_1^0$ | (53.70) | [53.73] | |
| 2s2p - 2s3s | ${}^3P_0^0$ - ${}^3S_1$ | (49.01) | [49.01] | 49.05 |
| | ${}^3P_1^0$ - ${}^3S_1$ | (49.08) | [49.07] | |
| | ${}^3P_2^0$ - ${}^3S_1$ | (49.21) | [49.20] | *49.24 |
| 2s2p - 2p3p | ${}^3P_0^0$ - ${}^3S_1$ | (42.90) | [42.92] | |
| | ${}^3P_2^0$ - ${}^3S_1$ | (42.95) | [42.97] | |
| | ${}^3P_2^0$ - ${}^3S_1$ | (43.04) | [43.06] | |

Note: Transitions in Angstroms.

( ) indicates prediction by [374].

[ ] indicates prediction by [776].

other values observed.

* blend

TABLE XXII

COMPARISON OF ENERGY LEVELS IN THE OXYGEN ISOELECTRONIC SEQUENCE

$2p^4$ Configuration

| | $^3P_0$ | |
|---|---|---|
| Sc XIV | (36200) | 34450 |
| Ti XV | (44800) | 38335 |
| V XVI | (54900) | 48617 |
| Cr XVII | (66700) | 56359 |
| | $^3P_1$ | |
| Sc XIV | (31200) | 30425 |
| Ti XV | (39300) | 38335 |
| V XVI | (48900) | 47700 |
| Cr XVII | (60200) | 58765 |
| | $^1S_0$ | |
| Ar XI | (143000) | 149188 |
| K XII | (154000) | 163500 |
| Ca XIII | (165000) | 179180 |
| Sc XIV | (175000) | 196440 |
| | $^1D_2$ | |
| Cl X | (62600) | 65262 |
| Ar XI | (67900) | 72338 |
| K XII | (73200) | 80080 |
| Ca XIII | (78400) | 88742 |

$2p^3 3s$ Configuration

| | $^1D^0_2$ | |
|---|---|---|
| K XII | (3013000) | 3024740 |
| Ca XIII | (3459000) | 3474352 |
| Sc XIV | (3936000) | 3954690 |

$2p^3 3s$ Configuration

| | $^3S^0_1$ | |
|---|---|---|
| K XII | (2929000) | 2929158 |
| Ca XIII | (3373000) | 3372241 |
| Sc XIV | (3847000) | 3845688 |
| Ti XV | (4351000) | 4349327 |
| | $^3P^0_0$ | |
| Mg V | (756450) | 756810 |
| Al VI | (993600) | 994320 |
| Si VII | (1261400) | 1262528 |
| S IX | (1888000) | 1891250 |
| | $^3P^0_1$ | |
| S IX | (1889000) | 1891851 |
| Cl X | (2248500) | 2252706 |
| Ar XI | (2638000) | 2644489 |
| | $^3P^0_2$ | |
| S IX | (1891000) | 1893325 |
| Cl X | (2251000) | 2255119 |
| Ar XI | (2642000) | 2648298 |
| | $^1P^0_1$ | |
| Ar XI | (2653000) | 2663504 |
| K XII | (3074000) | 3088799 |
| Ca XIII | (3525000) | 3545616 |
| Sc XIV | (4008000) | 4034152 |
| | $^3D^0_3$ | |
| Ar XI | (2589000) | 2590000 |
| K XII | (3007000) | 3008090 |
| Ca XIII | (3455000) | 3456980 |

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13. ABSTRACT

Approximately 900 unknown atomic energy levels were predicted by extrapolation along the helium through sodium isoelectronic sequences. The extrapolations, based on well known regularities in atomic spectra, extend beyond the range of known values providing predictions in highly ionized atoms. The predicted energy levels are presented, along with the known values, in tabular form. In addition, as an aid to spectroscopists, 116 transitions are listed with known and predicted wavelengths. Since the majority of the energy level predictions are in highly ionized atoms, most of the predicted wavelengths fall in the vacuum ultraviolet region of the spectrum.

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| Atomic Energy Levels | | | | | | |
| Predicted Wavelengths | | | | | | |
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| Ultraviolet Spectrum | | | | | | |

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Predictions of atomic energy levels by extrapolation along isoelectronic sequences: helium through sodium.